THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. XII.—*Barometric Indications of a Resisting Aether*;[1] by PLINY EARLE CHASE, M.A., S.P.A.S.

IN a recent communication to the American Philosophical Society, I stated that there are indications in the hourly barometric means, of disturbances which may, perhaps, be owing to a resisting medium. As the proper interpretation of those disturbances seems, in my opinion, to involve a consideration of the principal laws that govern molecular force, I desire to present some of the evidences on which my statement was based, and to invite an investigation of the subject by mathematicians and physicists.

The contrast between the light, volatile atmosphere, and the sluggish, ponderous mercury, is so great, that few persons would expect any slight variations of one to be accurately recorded by the other. But that such is the case, has been shown by my barometric investigations; and so minute is the apparent correspondence between the two fluids, that it does not seem unreasonable to look even for traces of æthereal disturbance in the mercurial column.

I believe no attempt was ever made to represent the daily ærobaric tides by general algebraic expression, prior to the one to which I was led by an *a priori* consideration of the effects of rotation.[2] The remarkable correspondence between the theoretical formula and the results of observation, being, as it is, far

[1] I prefer this spelling for the fluid which is supposed to pervade all space, to distinguish it from the liquid Ether of the chemists.

[2] Proc. Am. Phil. Soc., vol. ix, p. 285; and Sill. Jour. for May. 1864, p. 410.

within the limits of probable error, lends strong confirmation to my original hypothesis, and seems to require a revision of the reasoning which has led to the prevalent belief that all the influence of rotation must be constantly uniform, and therefore incapable of producing any tidal action.

Perhaps the error of that reasoning, as applied to the earth, has arisen from considering the joint action of rotation and orbital revolution, and making undue allowance for the mutual compensation of their mutual disturbances. That such compensation must be effected at every instant, I have no reason to doubt, but how is it modified by the stress of gravity and the stretch of molecular elasticity? That stress, at the surface of the earth, is nearly three hundred times as great as would be necessary to retain the particles in orbits at the same mean distance from the earth's centre; and since it probably follows a different law from the countervailing elasticity, it seems to me that each of the forces must be constantly accomplishing work. The value of this work must form an important element in all calculations of the effects of the earth's rotation, and, if it were properly ascertained, I have little doubt that it might be represented by a formula analogous to the one which I have deduced from the relative motions of the air and the earth's centre.[1]

I am inclined to believe, as I have intimated elsewhere, that a due consideration of these relative motions may help to explain other compensations, such as the variations in temperature and the deposition of dew during the night, the fluctuations of magnetic force, &c. I content myself, for the present, with a simple statement of the belief, because its confirmation or refutation will depend principally upon the results of the investigation that I am now inviting.

The following table is constructed from data furnished by Gen. Sabine's summary of three years' hourly observations at St. Helena,—a work of great value, on account of the number and accuracy of the observations, and the proximity of the station to the Equator. The 4th column, (B), represents the averages of the observed heights of the barometer at 0, 1, 2, and 3^{h} from each high and low ærobaric tide; the fifth column, (C), is the theoretical height, computed by the formula,

$$B = M\left(\frac{1+\sin\theta\cos\theta\cos l}{R^3}\cdot\frac{2C}{gt^2}\right);$$

the other columns require no explanation.

[1] It willl be readily seen that the sun's attraction is in the same direction as the earth's, and opposed to the molecular elasticity, at midnight; but at noon it acts with the elasticity, and against terrestrial gravity.

TABLE OF HOURLY THERMOMETRIC AND BAROMETRIC MEANS.

Astronomical time.	Temperature Fahrenheit.	(A) Observed height of barometer.	(B) Observed barometric averages.	(C) Theoretical height of barometer.	A—B.	A—C.	B—C.
h.	°	28 in. +	28 in. +	28 in. +	in.	in.	in.
0	64·392	·2985	·296125	·2970	·002375	·0015	−·000875
1	64·731	·2819	·28145	·2821	·00045	−·0002	−·00065
2	64·946	·2660	·267125	·2672	−·001125	−·0012	−·000075
3	64·639	·2553	·2572	·2563	−·0019	−·0010	·0009
4	64·108	·2521	·25355	·2523	−·00145	−·0002	·00125
5	63·174	·2562	·2572	·2563	−·001	−·0001	·0009
6	62·120	·2642	·267125	·2672	−·002925	−·0030	−·000075
7	61·403	·2764	·28145	·2821	−·00505	−·0057	−·00065
8	61·067	·2899	·296125	·2970	−·006225	−·0071	−·000875
9	60·828	·3003	·3077	·3079	−·0074	−·0076	−·0002
10	60·666	·3061	·31225	·3119	−·00615	−·0058	·00035
11	60·491	·3025	·3077	·3079	−·0052	−·0054	−·0002
12	60·330	·2913	·296125	·2970	−·004825	−·0057	−·000875
13	60·184	·2777	·28145	·2821	−·00375	−·0044	−·00065
14	60·002	·2646	·267125	·2672	−·002525	−·0026	−·000075
15	59·868	·2562	·2572	·2563	−·001	−·0001	·0009
16	59·779	·2550	·25355	·2523	·00145	·0027	·00125
17	59·691	·2611	·2572	·2563	·0039	·0048	·0009
18	59·664	·2737	·267125	·2672	·006575	·0065	−·000075
19	59·868	·2898	·28145	·2821	·00835	·0077	−·00065
20	60·575	·3048	·296125	·2970	·008675	·0078	−·000875
21	61·692	·3163	·3077	·3079	·0086	·0084	−·0002
22	62·635	·3184	·31225	·3119	·00615	·0065	·00035
23	63·578	·3117	·3077	·3079	·004	·0038	−·0002

The greatest theoretical error, (A–C,) is only ·0084 in. at 21^h, or ·000297 of the entire height, and ·127 of the daily range; the least error is at 5^h and 15^h, ·000004 of the height, or ·00151 of the range; and the average error ·0042 in., which is ·000147 of the height, or ·063 of the range.

The greatest difference between the observed height and the observed average, (A–B,) is at 20^h, when it is ·131 of the daily range; the least difference is ·0068 of the range, at 1^h; the average difference, ·0639 of the range.

The greatest difference between the observed averages and the theoretical height, (B–C,) is at low tide, or at 4^h and 16^h, when the difference is less than ·02 (say ·0189) of the daily range; the least difference is at 2^h from low tide, or at 2^h, 6^h, 14^h and 18^h, when it is but little more than ·001 (·00113) of the range; the average difference is only ·00926 of the range.

Both A–B and A–C show that some cause is operating from 1 or 2^h to 15^h inclusive, (say 2 P. M. to 3 A. M.,) to reduce the barometric pressure, while for the rest of the day the normal pressure is increased. That this cause is not to be found in differences of temperature, I think is evident, because the observations are already corrected for *known* effects of temperature, and

because the average height of the thermometer from 2^h to 15^h (61°·7) corresponds very closely with the average from 16^h to 1^h (61°·66).

The greatest unexplained reduction of barometric pressure is at 9^h; the greatest increase, at 20^h or 21^h. All these facts appear to me to admit of a ready explanation, on the hypothesis that the disturbances are caused by the resistance of an æther, which is condensed, as Fresnel supposes, by planetary attraction, and I can imagine no other hypothesis by which they could be satisfactorily accounted for.[4]

Mr. Colburn's inquiry into the nature of heat suggests some interesting speculations concerning other effects of rotation than those that can be measured by the barometer. Recognizing the impossibility that the sun should warm the whole solar system, as a simple incandescent body,—the improbability that its heat should result from continuous combustion, and the probable approximate uniformity of temperature in the upper regions of the atmosphere, in summer and in winter, by day and by night —Mr. Colburn looks for the principal sources of heat in the earth itself. He supposes, 1, that the solar attraction tends to draw into closer proximity the particles of air on the heated side, and to separate them on the night side of the earth, thus producing heat of compression, and cold of expansion: 2, that the change of eastward velocity from 69,000 miles per hour at midnight, to 67,000 miles at noon, (*sic*) necessarily produces a conversion of motion into heat, and of heat into motion: and 3, that if the earth is moving in a resisting medium, by which it is so retarded that it approaches the sun at the rate of 1,000,000 miles in 3,000,000 years, its "lift" involves the annual abstraction of a heat-force equivalent to 752,665,108,390,000 horse-power!

The third hypothesis has been often broached; the indications of a resisting ether, which, as we have seen, are furnished by the hourly barometric means, may, perhaps, yield the data for its final verification or rejection. The supposed separating effect of the sun's action in the most remote portions of the atmosphere, is so problematical that it seems hardly deserving of any consideration, and even if it existed, it is difficult to understand how it could produce a difference of more than a fraction of a degree in the range of the thermometer. The alternate acceleration and retardation of orbital velocity can produce no *accumulation* of heat to supply any loss that may arise from radiation into space, but it must modify the *distribution* of heat throughout the day in a manner that may be readily calculated. The available data are not sufficient to furnish us with complete results,

[4] The remainder of this article is taken from my communication to the American Philosophical Society.

but they give curious approximations that seem to open a wide field for profitable investigation.

"Sir John Herschel finds the direct heating effect of a vertical sun at the sea level to be competent to melt ·00754 of an inch of ice per minute, while according to M. Pouillet, the quantity is ·00703 of an inch."[5] Taking the mean of these two estimates (·00728 in.), multiplying by the latent heat of water (142·6° F.), and dividing by the number of cubic inches in 1 lb. of water (28), we obtain $\frac{\cdot00728 \times 142\cdot6}{28} = \cdot037076$ units of heat received per minute on each square inch of the earth's surface that is exposed to a vertical sun. The weight of the aërial column being 15 lb., and its ratio of specific heat 25, the maximum effect of the direct solar rays is sufficient to heat the whole atmosphere $\frac{\cdot0371}{15 \times \cdot25}$ per minute, or 7·12° F. in 12 hours.

Now, in consequence of the earth's rotation, the difference of atmospheric "lift" between noon and midnight, is 182,336 ft. per minute. The average difference for the twelve hours is one-half as great. "Rapid rotation, without friction or resistance, cannot in itself alone be regarded as a cause of light and heat;"[6] but we have found in our barometric investigations, that the ratio of the half-daily velocity of rotation to that which would be conferred by twelve hours' action of terrestrial gravity, is ·00109, which may be regarded as the modulus of heat-producing resistance. If we multiply the average difference of lift by the weight of the atmosphere and by the effective resistance, dividing the product by the ratio of specific atmospheric heat, and the number of foot-pounds raised by a unit of heat, we obtain $\frac{91168 \times 15 \times \cdot00109}{770 \times \cdot25} = 7\cdot74°$ F. as the amount of heat communicated to the air by rotation between midnight and noon, and abstracted between noon and midnight.

The theoretical barometric lift is, as we have seen, ·00219 of the entire weight of the atmosphere. Estimating the height of the aërial column when reduced to uniform surface density, at 24,000 feet, the heat-producing disturbance that is indicated by the barometer is represented by a lift of 15 lb. on each square inch to a height of ·00219 × 24000 feet. The quarter-daily disturbance from this cause is, therefore, $\frac{24000 \times 15 \times \cdot00219}{770 \times \cdot25} = 4\cdot1°$ F.

It is more than likely that each of these results will require important modifications when the entire influence of the several

[5] Tyndall, Heat considered as a Mode of Motion. N. Y. edit., p. 431.
[6] Dr. J. R. Mayer.

conditions of the problem is better understood. I have thought it proper to present them in their present crudity, in order to show the true points of departure, and to prepare the way for some further considerations.

Whatever other heat-disturbing causes there may be, there can be little doubt that the three we have just been considering are the most important. Dividing the astronomical day into four quadrants, and representing the solar effect by S., rotation by R., and barometric by B., it will be readily seen that the several positive and negative influences must be distributed as follows:

	S.	R.	B.
From 0^h to 6^h,	+	−	−
" 6^h to 12^h,	−	−	+
" 12^h to 18^h,	−	+	−
" 18^h to 0^h,	+	+	+

The tables of average temperature at any given place would therefore furnish us with four equations for determining the value of each of the disturbing elements, providing those that are unknown were so insignificant as to be safely neglected. The effects of these unknown disturbances are confined within certain limits that can be pretty satisfactorily determined.

Our discussion of the barometric fluctuations demonstrated a tendency of inertia to retard the effects of rotation, so that the mean daily altitudes are found nearer to 1^h, 7^h, 13^h, and 19^h, than to 0^h, 6^h, 12^h, and 18^h. A like tendency is discernible in the thermometer.

There are three, and only three, quadrantal divisions of the day, commencing respectively at 0^h, at 1^h, and at 2^h, for which we could obtain approximate positive values of S., R., and B. The maximum solar effect is deduced from the first, and the minimum from the third of these divisions; while the maximum rotative and barometric effects are exhibited in the third, and the minimum in the first division.

The nearest average temperatures are found in the third division, as is shown below.

Average of temperature at 2^h, 8^h, 14^h, and 20^h, and of the entire day.

Station.	Mean of the four hours.	Daily mean.
	°	°
At Girard College,.....	52·1	52·1
At St. Helena,.....	61·65	61·69

The following table presents all the coördinate positive values of S., R., and B., that can be obtained from the Girard College and St. Helena means.

Station.	Dividing at								
	0, 6, 12, 18h.			1, 7, 13, 19h.			2, 8, 14, 20h.		
	S.	R.	B.	S.	R.	B.	S.	R.	B.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Girard College,	45·92	41·32	12·76	31·3	49·5	19 2	13·8	63·2	23·0
St. Helena,	25·97	42·96	31·07	15·8	46·7	37·5	5·6	56·6	37·8

The percentages of the calculated values correspond very nearly with the means of the earliest Girard College and St. Helena values.

	Calculated values.	Percentage.	Mean Percentage.	Limits.	
S., - - - - -	7°·12	37·6	35·95	5·6	45·92
R., - - - - -	7°·74	40·8	42·14	40·8	63·2
B., - - - - -	4°·1	21·6	21·91	12·76	37·8

It may be inferred from this comparison that the rotation element of daily heat is least affected, and the solar element most affected, by extraneous causes (of which moisture is probably the chief); that the first division gives the best, and the third division the poorest, results; that the proportion of thermometric variation which is attributable to rotation is between ·4 and ·5 of the average total daily variation, and that the most difficult element to determine satisfactorily is S., which is modified by many local disturbing influences, such as the nature of the soil, amount of vapor, clouds, altitude of the sun, &c.

Philadelphia, May, 1864.

Art. XIII.—*On the Action of Oil-Wells;* by Prof. E. W. Evans, Marietta College.

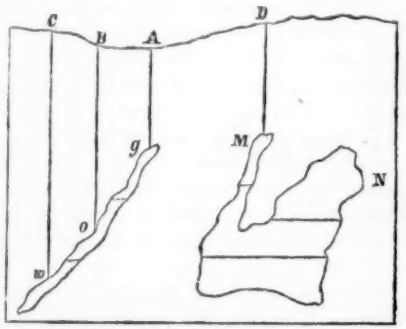
The phenomena exhibited by oil-wells suggest various problems, the discussion of which may be of scientific as well as practical interest. The facts on which the following remarks are based have been collected chiefly from the history of different wells in the coal regions of Southern Ohio and West Virginia.

It seems certain that the principal supplies of petroleum are not diffused between the planes of stratification, but are collected in cavities more or less sunken in the strata, whence it is less liable to be carried away by running water. Prof. E. B. Andrews has shown, in an article published in this Journal, July, 1861, that it is common to find large quantities in places where there are marks of disturbance and displacement of the rocks. The cavities have probably been caused sometimes by uplifts and sometimes by erosion and the dissolving action of water; but whatever may be their origin, they are not usually of great horizontal extent. It is seldom that two neighboring

wells strike oil at the same depth, whether the strata be horizontal or dipping. It is one chance out of many to strike oil at all, even in neighborhoods where it exists in abundance. The drill, as it enters the cavity, sinks variously from four or five inches to as many feet, sometimes sticking fast, as if between the oblique sides of a narrow fissure. But there are facts connected with the history of oil-wells, particularly their intermittent action and their interference with one another, which serve to show the existence, in many cases, of systems of these cavities connected together by channels of communication more or less free, running sometimes along the strata and sometimes across them. The productiveness of a well depends on its entering either one of the main reservoirs or some of its important connections.

Let us begin with the most simple case, that of a single or isolated oil-cavity; of which a cross section is represented by *gw*, fig. 1. Every collection of oil is accompanied with varying quantities of gas and water, the gas occupying of course the top of the cavity and the water the bottom, according to the order of their specific gravities. First suppose that a well is bored at A, so as to enter the gas. Being in a high state of tension the gas escapes, sometimes with explosive violence, carrying out with it whatever water there may be collected in the boring. If water enters the cavity freely, as is usually the case, the oil, floating on its surface, is soon driven upward to the mouth (i. e., lower end) of the tube; it may then be pumped out till the line of division between it and the water rises to the mouth of the tube; after which, mixed oil and water will be drawn. But it often happens that the water rises faster than it can be thus exhausted, and the oil, driven into the top of the cavity, is lost, until the water is reduced by machinery of greater working power. But as it cannot be reduced below the mouth of the tube, unmixed oil cannot again be obtained from the well. In all wells from which the gas has escaped, there is ultimately a saving of work if the oil is pumped out as rapidly as possible before the intrusion of water. Secondly, suppose that the boring is at B and enters the oil. In this case, the oil rises in the tube to a height depending on the tension of the gas above it; a mode of action which is illustrated by the familiar apparatus called

1.



the fountain with condensed air. Sometimes it is thrown into the air a distance of 30 or 40 feet, and large quantities wasted. If the oil continues to be ejected till its surface in the cavity descends to the mouth of the tube, the fact first becomes known by a gurgling and spurting action, and the gas, or the greater portion of it, escapes, after which the pump becomes necessary, and the same series of actions take place as in the first case. But if the gas reaches its equilibrium with the hydrostatic pressure before the oil is reduced so low, we may then pump out the oil till the water rises to the mouth of the tube, after which we shall obtain mixed oil and water as before, till the whole supply of oil is exhausted, provided the pump is of sufficient working power to prevent interruptions by the too rapid rise of the water.

Next suppose that the boring is at C and enters the water. If the gas has sufficient tension, water is raised until its surface in the cavity descends to the mouth of the tube, then mixed oil and water is obtained, then pure oil, after which the same circumstances exist as in the second case. It must not be inferred, however, that when the water is not thrown to the surface there is no oil. It may happen that the pressure of the gas will raise a column of water only part of the way up the boring, and yet the well be found productive. Hence no considerable quantity of water should be passed without ascertaining by reducing it with the pump whether there is oil confined above it in some side chamber. The Shattuck well on the Little Kanawha had to be drained of water with a steam pump for two weeks before oil was obtained; but after that it yielded abundantly.

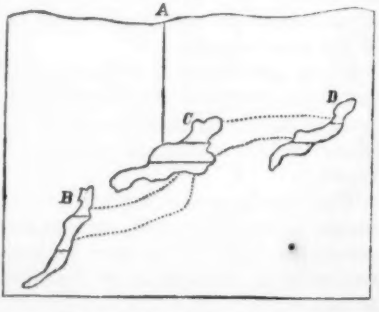
Some varieties of action are to be accounted for on the supposition that there are, in the same cavity, different collections of gas separated by a partition descending from the top. Such a cavity is represented by MN, fig. 1. A well enters the gas chamber M. The gas escapes with violence, and yet the oil immediately begins to flow in a continuous stream over the top of the boring, and is perhaps projected in the form of a jet to a great height, by the pressure of the gas in another chamber N, of the same cavity.

It is evident that if a second well be sunk so as to enter the gas in the chamber N, the oil in M will immediately sink to the level of that in N, and be lost to the first well; a mode of interference which sometimes occurs, when two wells are quite near together.

Thus far I have considered only isolated oil-cavities, or those which, when exhausted, are not replenished to any considerable extent from other sources. In general these run their course in a short time, and yet they sometimes yield very large quantities of oil.

There is a second class of wells, in general more productive, which exhibit the same phenomena at first, but as often as they are exhausted are replenished again, and repeat a certain series of actions indefinitely, and with remarkable regularity of time. This is to be explained by supposing that they are connected with other reservoirs by slight channels of communication, whose capacity for replenishing is less than that of the tube for exhausting. Let C, fig. 2, be an oil cavity having connections with two other cavities, B and D. Suppose that a well A enters the oil in C. After this well has thrown out oil, and perhaps afterward water, by force of the condensed gas, it comes to a stop. Then owing to the diminished tension of the gas in the enlarged space in C, the gas and oil in B and D force slight passages, represented by the dotted lines, into C, until the gas in this cavity again becomes sufficiently compressed to raise oil and water successively; after which the well comes to another stop until it is replenished with oil and gas as before; and the same process is repeated an indefinite number of times. The Newton well, on a branch of the Little Muskingum, a few miles from Marietta, repeats this process (with some escape of gas) at regular intervals of about half an hour, expelling about a barrel of oil each time. A note-worthy fact connected with this well is that when it stops it is necessary to pump out a little water in order to start it again; then the oil issues spontaneously. This is to be explained as follows. The pressure of the gas is not quite sufficient to raise the water to the surface; but the position of the mouth of the tube is such that a few strokes of the pump suffice to reduce the surface of the water in the cavity below that point. Now a column of oil will be raised by a given pressure so much higher than a column of water as its specific gravity is less. In this case it is raised not far from a fourth higher (the specific gravity of the oil being ·816); and the difference is sufficient to make it flow over the top of the tube. Examples of this kind are common.

2.



The well in the figure is represented as having but a few connections, sufficient perhaps for the purpose of illustration; but it is probable that these lines of slow communication are usually numerous: the gas and oil, like the water, forcing their way in through a multitude of pores and slight crevices, until a state of equilibrium is gradually reached or approximated to, as mercury forces its way in through the pores

of wood into the exhausted receiver of an air-pump. Sometimes it happens that the cavity is filled with sediment of clay and sand by these little streams, and the well becomes inactive.

The class of wells here described may be distinguished from others as intermittent wells. The finding of one of these may be regarded as a certain sign that there are numbers of oil cavities near together in the same locality. Especially if it yields copiously for months in succession, as often happens, without any material diminution in quantity, or increase of the intervals between the successive yields, the rocks in its neighborhood may be presumed to contain rich supplies of oil that may be directly reached.

On Oil Creek in Pennsylvania the greatest quantities of oil are found in the same horizontal stratum of sandstone. It would seem that this rock is very porous, and perforated like a honeycomb with numerous cells and fissures containing petroleum. The history of many of the wells is as follows. When oil is entered, the gas begins to raise it up over the top of the boring, increasing gradually in force until it projects it into the air, often to a height of 40 or 50 feet, then alternately diminishing and increasing in force at regular intervals, but without any cessation in the flow for a long time. These variations in the force of the gas (the "breathings of the earth," as they are called,) are to be explained on the same principle as before, by supposing that as the tension of the gas is relaxed by the removal of oil, the gas and oil from other cavities around rush in through the pores and slight fissures till a certain maximum tension is reached, and the influx ceases; then by the expansion of the gas already in the chamber the oil continues to come up, but with a diminishing flow, until a relative vacuum is again created; after which the influx is renewed and gradually increases as at the beginning. These regular alternations vary in different wells from two or three times a day to as many times an hour; the intervals, however, gradually increasing in length as the supply of oil is diminished; unless, as sometimes happens, new communications are forced, and the well, deriving new supplies, starts off again with a new period. It often happens that the same well has two periods;—one of variation in the flow, and another of cessation, consequent on the escape of gas.

A more uniform flow may be secured by making the orifice at the mouth of the tube smaller. This is often desirable in order to prevent the escape of gas by the exhaustion of the oil in the cavity down to the bottom of the boring. Sometimes such a quantity will thus rush out, before the oil raised up by the water, closes the passage again, as not only to render the pump necessary after that to raise oil, but also to diminish materially the influx of oil from other cavities by reducing the pressure of the gas in them. Another expedient sometimes resorted to, when

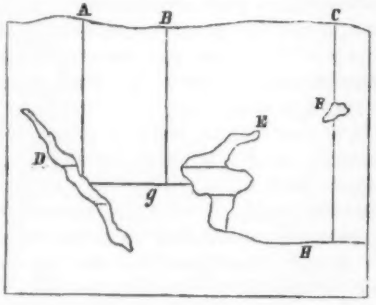
the spontaneous flow of oil becomes slight, is to stop up the boring till another "head of gas," as it is called, accumulates. But the stoppage should not be continued long; for instances are known where the gas has in consequence forced a way from its new channels in other directions, and found vent in other wells.

It is not an uncommon thing for intermittent wells to throw out at first 300 or 400 barrels a day, or to yield in all as much as 20,000 barrels. They sometimes run two or three years before exhaustion. The productiveness of the Lewellyn well on the Little Kanawha greatly exceeded these figures.

It is evident that if a second well were sunk so as to enter the cavity B or D, fig. 2, the well C would lose one portion of its supply of gas and oil, and be to this extent interfered with. Sometimes a very productive well thus cuts off the main supplies of a number of less considerable ones in its neighborhood, or, if the first sunk, it is itself tapped by them.

But some of the most marked cases of interference that are known, show the existence of a third class of oil cavities, connected with one another by perfectly free channels of communication, so that when the equilibrium between them is disturbed, it is immediately restored. Fig. 3 will serve to illustrate. A well A enters the cavity D finding oil. Another well B is bored so as to enter an open channel *g* between the two cavities D and E. This will drain oil from A; but if, as in the figure, its mouth is lower than that of A, it can be made a valuable auxiliary to it when the rising water drives the oil into the upper part of the cavity; for it can be used to reduce the water, and thus to keep the oil within reach of A.

3.



Again, a third well C is bored, and passes through a strong current of water, a cross section of which is represented by F. It finally descends to a fissure H, which communicates freely with E and consequently also with D, and interferes with both the other wells by letting in such a head of water as to drive the oil in both cavities above the mouths of the tubes. Pumping the water out of all these simultaneously might bring the oil down again within reach of that tube at least which enters at the highest point. A better expedient is to stop up tightly the space on the outside of the tube in the well C, just below the stream of water F. This is often effected by lowering a leather

bag filled with dry seeds to the required depth. As water penetrates it, the seeds swell and close the passage.

On the Little Muskingum there are four or five wells (from 100 to 200 feet apart), so connected together as to illustrate both modes of interference shown by fig. 3. Had the well B entered the gas in E, it would have interfered with A by causing the escape of this gas; a case analogous to that mentioned before, where there were supposed to be two gas chambers in the top of the same cavity. After this the irruption of the water from C would have temporarily assisted B by raising the oil in E to the mouth of the tube.

Examples differing in details might be multiplied indefinitely. I have aimed only to point out in a general manner the different modes of action, and the hypotheses on which they are to be explained.

In the foregoing illustrations the quantity of gas has been supposed considerable. In many cases however it is so slight that the pump has to be used throughout. Yet wells of this kind often partake of the intermittent character to some extent. As it is not usual to work them at night, they begin each day with a new accumulation, which gives them a certain regularity of daily action often considered mysterious. There is a well a few miles from Marietta which yields oil only for a short time in the morning; when neglected till that time is passed, it is unproductive for the day. This is owing to the proximity of another well, which drains it of its water in the daytime, but by resting at night allows it to be replenished. Wells of small supply often require a certain interval of rest to be replenished, but never exceed a certain amount, however that interval may be extended—the column of oil having reached its maximum height by pneumatic or hydrostatic pressure.

Oil-wells commonly vary in depth from 100 to 800 feet. The deepest are as apt to raise oil to the surface as the shallowest. This indicates a greater compression of the gas at the greater depth, owing doubtless to its connection with higher columns of water. The activity of some wells is increased by rains; others, with less gas, are rendered unproductive till the water can be reduced. It must not be assumed however that their connection with subterranean currents is immediate and unobstructed. I know of no instance where there is reason to suppose that the oil is raised to the surface by the direct pressure of a stream of water whose head is higher than the issue, as the jets of Artesian wells are said to be produced. In spouting wells, the presence of gas as the immediate agent becomes known, not only from their variable action, but also from the actual escape of gas, and consequent cessation of flow whenever the oil is reduced to a certain level. If collections of oil had direct and free connection

with strong currents of water, the mechanical agency of these currents would bear them rapidly away.

As it is, minute quantities come to the surface with the springs, showing a very slow process of drainage. As an index of the location of oil-cavities this sign is not reliable; for that which issues may have been carried by the streamlets many miles from its source. Gas springs are less deceptive signs; for the gas, being more buoyant than the oil and not liable to be carried along by descending currents, is not likely to wander so far before it issues. But the "show of oil" increases in value as a sign with the depth at which it is found. Especially is the finding of large quantities of imprisoned gas, though no oil may be present, regarded as a good indication that there is oil near.

Marietta, May 4th, 1864.

ART. XIV.—*Description of a new Machine for Cataloguing and Charting Stars;* by G. W. HOUGH, A.M.

THE progress of instrumental astronomy has been so rapid during the last half century, not only in the perfecting of the older instruments, but also in the invention of new methods of observation, that at the present time, in certain kinds of work, more observations can be made in one year than could formerly have been done in five.

In the year 1848, the application of electricity to the recording of Astronomical Observations was first suggested. This happily conceived idea soon resulted in the construction of Chronographs by various persons, by which the instant of transit of a star was accurately recorded in a legible and permanent manner. Success in the recording of one ordinate of a star's position would naturally suggest the possibility of fixing the other by the same agency. But with the exception of some experiments made by the late Prof. O. M. Mitchel for the recording of declinations by electricity, this subject, so far as I know, has not been undertaken by any other astronomer.

In the formation of catalogues of zone stars, astronomers have almost invariably used the Telescope in a fixed position, and, by means of a diaphragm or scale placed in the focus, determined the time of transit and difference of declination. In our method, the Telescope is moved in zenith distance, the amount of motion giving us the difference of declination.

This method of observing the difference of declination between two objects, by magnifying by mechanical means the angular motion of the Telescope, is due to the late Prof. O. M. Mitchel, who first put it in practical operation in the year 1849; the apparatus used for this purpose being called the "Declinometer," an account of which will be found elsewhere.

Perhaps nothing is more desirable at the present time than accurate Ecliptic Charts of all stars down to the 14th magnitude. We already have the Charts of Chacornac, Argelander and others, which are of great value in the search for Asteroids; but were these charts filled out, as it were, with stars of a higher order of magnitude, it would greatly enhance their value for this purpose.

All standard charts, that have heretofore been constructed, have been made by laying down the positions of the stars, as given by a catalogue previously formed. This, of course, is an extremely difficult and tedious task. It seemed to me that much time and labor might be saved, provided we could make an accurate map at the same time that we observed for exact positions. This result we have succeeded in accomplishing by means of easy and simple mechanism, a description of which will be given in this connection.

In the cataloguing of zone stars with the Olcott Meridian Circle, during the year 1862, I found it desirable to have some contrivance by which we could observe the same zone, star for star, on a subsequent night. In order that we may be understood, we add that the clamp arm for giving slow motion to the Telescope in zenith distance, is moved by a screw pressing against its lower end, one revolution of the screw being about 6′. That we might get more rapid motion, an extra cog wheel was made to drive one fastened to the screw. To the axis of this new wheel was attached two cylindrical pulleys, each carrying a small weight suspended by a cord wound on the surface of the pulley. The width of the zone was then regulated by the length of the end left free to move.

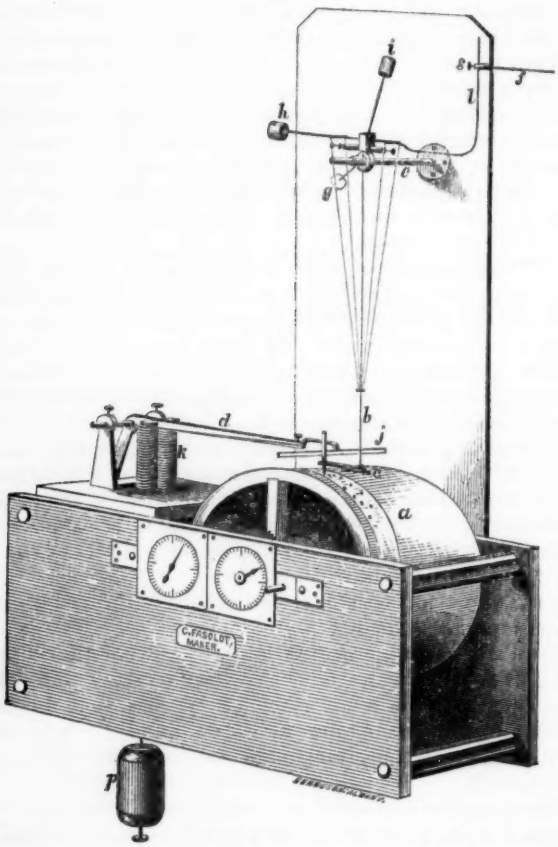
It was found that with this contrivance (although we had the play between the two cog wheels), we could follow the same zone with a deviation of less than 5″. Were the pulleys attached directly to the screw, we know the error would be still less. From this fact, we were led to surmise, that difference of declination could easily be read to the tenth of a minute, from a screw head used for giving slow motion to the Telescope, in zenith distance.

In thinking on this subject, I conjectured that if a cylinder were attached to this screw, and a pen be made to move over it with a uniform velocity in the direction of its length, we could readily record both Right Ascension and Declination, or, in other words, make a map of the stars observed. Owing to inconvenience in attaching such an apparatus to our instrument, the plan was not put into execution.

I will now proceed to give a description of the Charting machine. Fig. 1 is a perspective of the machine, as seen from the southeast. This apparatus is firmly fastened to the south side of the west pier. It is connected with the clamp arm of the Telescope by means of the horizontal rod (*f*), 40 in. in length.

A clock work mechanism, having a half second's pendulum (*p*), carries the cylinder (*a*), 6 in. in length and 10 in. in diameter; which revolves from west to east, and makes a complete revolution every hour.

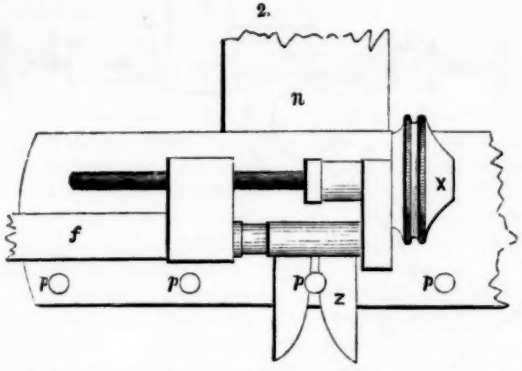
1.



Directly over the cylinder is mounted, on a horizontal axis, the compound lever (*bl*); to the lower end of which, by means of a short horizontal arm and joint, a hollow cylindrical steel pen is held in a vertical position over the axis. The lower part of this lever (*b*) is 18 in. long; the upper part (*l*) is 6 in. long. In order to magnify as much as possible the angular motion of the clamp arm, we attach to it a strong iron bar, 25 in. in length. At the lower end of this bar is a cross piece, fig. 2, 6 in. long, holding a number of cylindrical pins (*p*).

Each of these pins has a notch cut in the middle, of the form which would result from placing the vertices of two cones together. By this arrangement, there can be no loss of motion; besides, it affords great facility in changing the rod from one pin to another.

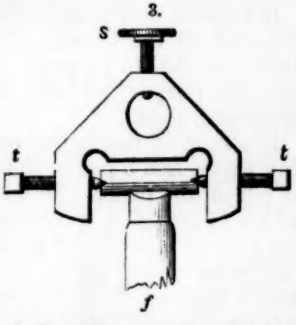
2.



The rod (*f*) is connected with the clamp arm by dropping the notch (*z*), fig. 2, on one of the pins.

The other end of the rod is attached to the lever (*l*), fig. 1. A sectional view of the mechanism for this purpose is seen in fig. 3; (*t*, *t*) being two screws having conical points, (*s*) a set screw for clamping to (*l*).

3.



The arm carrying the steel pen, shown at (*c*), fig. 1, is attached to the lever (*b*), by an arrangement similar to that seen in fig. 3, with the exception that there is no joint or axis, the steel pen being held in position by a flat spring attached directly to the lever (*b*).

The lever (*b*) is supported on the horizontal post (*e*), fig. 1; *g* is a set screw for clamping to any part of the post (*e*); *h* and *i* are weights for counterpoising the lever in any position.

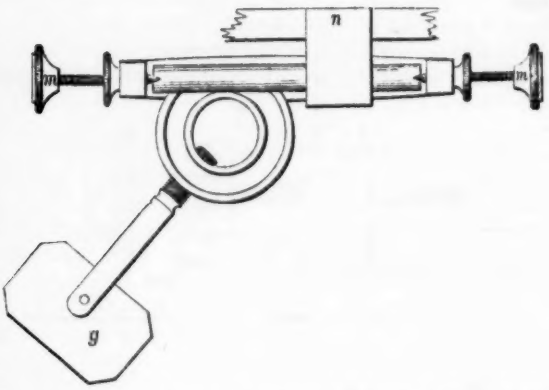
The supporting axis of *b* is seen in fig. 4, where *m m* are two screws having conical points. By this arrangement, we avoid all loss of motion, and have but very little friction.

In fig. 1, *k* is an electro-magnet operating the arm (*d*), at the end of which, and parallel to the axis of the cylinder, is attached the cross piece *j*.

The dials seen in fig. 1 indicate minutes and seconds.

Now, when the telescope is moved in zenith distance, motion is given to the steel pen so that it moves over the cylinder in the direction of its axis. Whenever we wish to make a record, a

4.



key is pressed which closes the circuit through the electro-magnet, and a blow is struck on the arm carrying the steel pen; so that a small dot is made on the sheet of paper covering the cylinder.

It remains now to show how the magnitudes of the stars are recorded on the Chart. Various plans were suggested, and I finally decided to represent the magnitudes by different colors. For this purpose we use prepared paper, known as duplicating impression paper.

If a strip of this paper be laid over a sheet of ordinary writing paper, and a pen be drawn over it, a colored impression will be left on the paper. In the same manner, if a blow be struck with a blunt point, a colored dot will be the result. Now, if at the time of observation an assistant should introduce a strip of this paper under the steel pen, when the record was made, we would have a colored impression denoting the magnitude. So, it is readily seen, should an assistant introduce these strips of paper as required, we should produce our chart with the magnitudes all recorded. But obviously this method would require an extra-assistant, and consequently be an unnecessary waste of time. It is then very desirable that the introduction of these strips of paper should be in the power of the observer himself.

Various kinds of apparatus might be employed to take the place of the assistant; but what we need is simplicity and certainty. We at first placed our strips on a belt running over two rollers, so that, by giving motion to these rollers, any strip of

colored paper could be brought under the recording pen. This plan answered the purpose, but made it somewhat inconvenient to put our sheets on the cylinder. We therefore removed it and placed the strips of paper on an arm moving about a vertical axis; and by means of a cord attached to a lever connected with the rod used for giving motion to the telescope in zenith distance, the observer was enabled to bring any color under the pen he desired, and this too without removing his eye from the telescope.

This part of the apparatus is not shown in the drawings, but being so simple the reader will not fail to understand it. So far we have used only five different colors, but the number can be increased to any extent. These colors indicate 9, 10, 11, 12 and 13th magnitudes. When stars of the 14th magnitude are observed, no color is introduced, and we have for our record merely a puncture on our zone sheet. When stars below the 9th magnitude are observed, (and there are but few, generally three or four in a night,) a note is made by the assistant, and they are recorded on the working chronograph by striking a certain number of dots to indicate the magnitude.

As fast as the stars enter the field of the telescope, they are brought to the intersection of a horizontal and vertical wire, when, the circuit being closed, the record is made. In this way, the position of the stars in the heavens are transferred to the surface of the cylinder, so that when our observations are finished, we have a perfect "*fac simile*" copy of the zone of stars observed.

This apparatus we believe is the first which has been constructed to record accurately, by mechanical means, the Right Ascension and Declination at the same instant, or in other words, to make a chart of the stars observed. When the dot is made on the cylinder, a record is also made on the working chronograph, which gives us the time to the hundredth part of a second. For the exact declination, an assistant reads the declinometer scale to the five-tenths of a second. Therefore, when our zone is observed, we have not only a complete catalogue of the exact positions of the stars, but also a perfect map of the heavens.

In case we do not read our declinometer scale, we can determine the declination from the chart, within one-tenth of a minute of arc. The precision with which this machine will map stars is all that could be desired; since if two charts of the same zone, made on different nights, be placed one over the other, the stars will be superimposed so that the eye can detect no difference.

By means of movable adjustments, we can set the machine (having our sheet ruled for Right Ascension and Declination) so that it will give the position of the zone, at the beginning of the year, without sensible error. For adjusting in Right Ascen-

sion, the cylinder can be moved about its axis, being held in position by a friction block. For the declination, we lengthen or shorten the rod (f) by means of the screw (x), fig. 2. The scale for declination can be varied at pleasure, by changing the position of the connecting rod (f) on the lever l, fig. 1. This apparatus can be adapted to any telescope, either transit or equatorial; neither does its use interfere with the ordinary work for exact positions.

In the observation of asteroids on the meridian, a great deal of time is wasted, especially when the error of the ephemeris is considerable. And even when the error is only 2′ or 3′ in declination, in certain portions of the heavens, it is almost impossible to find the body with a meridian instrument.

This apparatus affords great facility in finding these bodies, when we have an approximate Ephemeris; since it is only necessary to observe, on two nights, a short zone of five minutes in Right Ascension and 10 minutes in declination. The comparison of these two charts will at once show which is the planet, provided it is included within those limits; when, the Ephemeris being corrected, it can be observed on the meridian in the usual way. This has already been tested in finding some of the old asteroids, using for our Ephemerides Hind's Supplement to the Nautical Almanac.

In our ordinary work, as we observe all stars visible, the limit being 13-14 magnitude, it is usually impracticable to observe a zone of greater width than 10′ or 12′; and within these limits, it is not unusual to find more than 200 stars in one hour of Right Ascension.

In case we wish to extend our observations over more than one hour of Right Ascension, we loosen the clamp screw (g), fig. 1, and slide the whole apparatus carrying the pen, on the post e; the end of the connecting rod (f) being raised up and dropped on another pin. These changes can all be made in less than one minute.

During the past year we have observed and charted six thousand stars, being the result of forty hours' observation. From the comparison of the positions given by the chart with those found with the declinometer, the mean error in the chart position, in declination, is found to be less than the one-tenth of a minute of arc. Our work with this apparatus so far has been almost entirely confined to cataloguing and charting a zone of stars lying between the equator and 10′ of south declination. In the prosecution of this work these charts have been found of great value in correcting doubtful observations, without the necessity of re-observing the zone. In case a wrong minute is entered by the assistant charged with taking down the declinometer readings and other remarks, on comparing with the chart

we readily make the necessary correction. The use of this apparatus in no wise interferes with our work for exact positions, since we have found the mean error of our observations to be the same whether the stars were charted or not.

Our work for the past year has demonstrated the practical utility of this apparatus. If for any purpose we desire a map of the stars in a certain position of the heavens, we can make one in a few minutes, which by any other method would require hours. In the region of the milky-way, where small stars are very numerous, we have charted them at the rate of 480 per hour, and at the same time observed every star above the 14th magnitude.

Every one will at once see, that a series of charts, even in the condition in which they are taken from the cylinder, will be of great value to the observatory in which they are made. For, after being numbered and filed, they become so many maps, although the width does not exceed 10 minutes of arc. But obviously they can be made of greater service, with but little additional labor, by transferring contiguous zones to one sheet. This is easily accomplished by merely pricking through the paper, with a series of points which shall at once indicate the magnitudes.

In case we wish to search for Asteroids, we believe much labor can be saved, and equal if not greater facility afforded in their discovery. For, suppose we have already completed a series of charts for one hour of right ascension, and one degree declination, it is only necessary to observe and map the same zone, or any portion of it; when it is readily seen, should there be any asteroid in that region which was not there when the former charts were made, it will at once be detected.

The objection may be offered, that, with the ordinary meridian instruments, we do not have optical power sufficient to detect these faint bodies. Granting this to be the case, it does not affect the principle of the method, for we can use the apparatus with an equatorial of any size. In the latter case, we would clamp the telescope securely in the meridian, and, attaching an arm to the declination axis, at once connect our apparatus in the same manner as with the transit. Slow motion in declination can now be given to the telescope with the tangent screw, and the width of the zone limited by employing any mechanism suitable to the instrument. These minor details, of course, will be arranged by the observer, as circumstances require.

Dudley Observatory, March 16th, 1864.

ART. XV.—*Contributions to Lithology;* by T. STERRY HUNT, M.A., F.R.S.; of the Geol. Survey of Canada.

(Concluded from p. 104.)

DOLERITES.

The anorthosites, which yet remain to be described, may be divided into two groups, those composed of anorthic feldspars with augite, constituting the dolerites, and those in which similar feldspars are associated with hornblende. The general geognostical relations of these two groups of rocks in the districts under discussion have already been indicated.

Grenville.—It has already been stated on page 93, that the oldest known intrusive rocks which traverse the Laurentian series are of dolerite, and that the dikes of this rock are intersected by the syenite, which was succeeded by the orthophyre or quartziferous porphyry. Nothing corresponding to the syenite or the orthophyre is met with among the adjacent Lower Silurian strata, which are seen to repose upon the worn surfaces of these intrusive rocks. A fourth series of dikes, of a porphyritic dolerite, is however found to cut all the preceding rocks, and is perhaps identical with some of the dolerites which intersect the Silurian rocks of the island of Montreal. In the other parts of the Laurentian series, so far as yet examined, intrusive rocks have been but seldom met with. Much of what has been called syenite and granite in various parts of the Laurentian region, seems, like the hypersthenite and other anorthosites of the Labrador series to be indigenous.

The dikes of this most ancient dolerite or greenstone in Grenville, have a well marked columnar structure at right angles to the plane of the dike. They are fine grained, dark greenish-gray in color, and weather grayish-white. Under a lens, the rock is seen to consist of a greenish-white feldspar with a scaly fracture, mingled with grains of pyroxene, occasional plates of mica, and grains of pyrites. It contains no carbonates. Two analyses of portions of the dolerite, from dikes differing a little in texture, gave as follows under XV and XVI:

	XV.	XVI.	XVII.
Silica,	50·35	50·25	52·20
Alumina,	17·35	32·10	18·50
Peroxyd of iron,	12·50		[1]10·00
Lime,	10·19	9·63	7·34
Magnesia,	4·93	5·04	4·17
Potash,	·69	·58	2·14
Soda,	2·28	2·12	2·41
Volatile,	·75	1·00	2·50
	99·04	100·72	99·26

[1] With some titanic acid.

The iron in these analyses, although given above as peroxyd, exists in the form of protoxyd, and in the second specimen, in part as a sulphuret. These rocks, which appear to have the composition of mixtures of a basic feldspar with pyroxene, do not differ from ordinary dolerite.

The newer dolerite, which cuts the three other classes of eruptive rocks in the Laurentian region, has a grayish-black, very fine-grained base, earthy and sub-conchoidal in fracture, and resembling somewhat the preceding. It contains small brilliant black grains of ilmenite, with others of sphene, and small scales of mica. Occasional masses of black cleavable augite, sometimes half an inch in diameter, give to the rock a porphyritic character. It contains besides, small cleavable masses of white carbonate of lime, with which the whole rock seems penetrated. When in powder it effervesces freely in the cold with dilute nitric acid, and the solution evolves red fumes on heating. In this way there were dissolved, lime, equal to 8·70 per cent of carbonate, 0·50 of magnesia, and 6·50 of alumina and oxyd of iron =15·70 per cent. The residue dried at 212° F., equalled 83·80 per cent. A portion of aluminous silicate had evidently been attacked by the acid. The dried residue gave on analysis the results which will be found above under XVII.

The dolerites of the Montreal district, besides forming numerous dikes, constitute the chief portions of the mountains of Montarville, Rougemont, and Mount Royal. In all of these however great diversities of composition are met with, which will be successively noticed.

Montarville.—The greater part of Montarville is composed of a coarse-grained granitoid dolerite, in which black cleavable augite predominates,—sometimes almost to the exclusion of any other mineral. Small portions of white feldspar, and scales of brown mica, are sparsely scattered through the rock, with grains of carbonate of lime. The removal of these by solution from the weathered surface often gives to it a pitted character. In other portions, the feldspathic element predominates, and the rock becomes porphyritic from the presence of large crystals of augite. The worn surfaces of the dolerite sometimes show alternations of this variety with another which is finer grained and whiter. The two are arranged in bands, whose varying thickness and curving lines suggest the notion that they have been produced by the flow and the partial commingling of two semi-fluid masses.

Another and a remarkable variety of dolerite, found at Montarville, appears to be confined to a hill on the shore of a little lake about half a mile northward from the manor house. The whole of this hill, with the exception of some adherent portions of indurated shale, seems to be composed of a granitoid dolerite, containing a large proportion of olivine. This mineral occurs

in rounded crystalline masses or imperfect crystals from one tenth to one half an inch in diameter, associated with a white or greenish-white crystalline feldspar, black augite, a little brown mica, and magnetite.

The proportion of olivine is very variable, but in some parts it is the predominant mineral. Its color is olive-green, passing into amber-yellow. The grains, which are translucent, are much fissured and very brittle. The pulverized olivine gelatinizes with chlorhydric acid in the cold, and is almost instantly decomposed when warmed with sulphuric acid diluted with its volume of water, the silica separating chiefly in a flocculent form, and enclosing small grains of the undecomposed mineral, which are left when the ignited silica is dissolved by a solution of soda. A little silica is however retained in solution, and is precipitated by ammonia with the oxyd of iron. Two analyses of different portions of the olivine made in this way gave, after deducting the undecomposed mineral, the following results:

Silica	37·13	37·17 = oxygen	19·82
Magnesia,	39·36	39·68 = "	15·87
Protoxyd of iron,	22·57	22·54 = "	5·10
	99·06	99·39	

The augite of this olivinitic dolerite appears in the form of small crystalline grains, and also in short thick and terminated prisms, which are readily detached from their matrix. They are often an inch in length by half an inch in diameter, and are sometimes partially coated by a film of brown mica. These crystals cleave readily, presenting brilliant surfaces, and are black in color, with an ash-gray streak. Their hardness is 6·0, and their specific gravity 3·34. Analysis gave as follows:

Silica,	49·40
Alumina,	6·70
Lime,	21·88
Magnesia,	13·06
Protoxyd of iron,	7·83
Soda and traces of potash,	·74
Volatile,	·50
	100·11

The augite which abounds in the non-olivinitic dolerite, which forms the greater part of Montarville, does not appear to differ from that just described.

An average specimen of this olivinitic dolerite, or peridotite, was reduced to powder; it did not effervesce with nitric acid, and when ignited lost only 0·5 per cent. When gently warmed with sulphuric acid, the olivine was readily decomposed, with the separation of flocculent silica; and by the subsequent use of a dilute solution of soda, followed by chlorhydric acid, and a second treatment with the alkaline ley, 55·0 per cent of the

whole were dissolved. This portion consisted of silica 37·30, magnesia 33·50, protoxyd of iron 26·20, alumina 3·00=100·00; being equal to 18·4 of magnesia for the entire mass. In another experiment, 18·0 per cent were obtained. Taking the mean of the two analyses of olivine above referred to, which gives 39·5 per cent of magnesia, 18·0 parts of this base corresponds to 45·5 parts of olivine. The remaining 9·5 parts of dissolved matter represent alumina and silica from the feldspar, and oxyd of iron from the magnetite; both of which were somewhat attacked by the acids. The undissolved portion of the rock equalled 44·7 per cent, and appeared to consist of a feldspar with pyroxene, some mica, and a little magnetite. Its analysis afforded silica 49·35, alumina 18·92, protoxyd of iron 4·51, lime 18·36, magnesia, 6·36, loss (alkalies ?) 2·50=100·00.

In some portions of the dolerite of Montarville the feldspar is more abundant, and appears in slender crystals with augite, and with a smaller proportion of olivine than the last. A specimen of this variety being crushed and washed gave 3·9 per cent of magnetite, and 10·0 per cent of a mixture of ilmenite with olivine. The feldspar was obtained nearly pure, in yellowish vitreous grains, having a specific gravity of 2·73—2·74, and nearly the composition of labradorite. The results of its analysis are seen under XVIII.

	XVIII.	XIX.
Silica,	53·10	53·60
Alumina	26·80	24·40
Peroxyd of iron,	1·35	4·60
Lime,	11·48	8·62
Magnesia,	·72	·86
Potash,	·71	undet.
Soda,	4·24	"
Volatile,	·60	·80
	99·00	....

The dolerite of Montarville is traversed by veins belonging to several different periods. In one instance, the black and highly augitic mass is cut by a dike of a fine-grained grayish-white dolerite. This is intersected by a dike of a fine-grained greenish rock, which, in its turn, is cut off by another small dike which is grayish-white like the first.

Rougemont.—The rocks of Rougemont offer a general resemblance to those of Montarville. Some portions are a coarse-grained dolerite, in which augite greatly predominates, with grains of feldspar, and a little disseminated carbonate of lime. In some parts, the augite crystals are an inch or more in diameter, with brilliant cleavages; and grains of pyrites are abundant, with calcite in the interstices. This rock resembles the highly augitic dolerite of Montarville. Olivine is very abundant in two varieties of dolerite from Rougemont. One of these

has a grayish-white finely granular feldspathic base, in which are disseminated black augite and amber-colored olivine, the latter sometimes in distinct crystals. The proportions of these elements sometimes vary in the same specimen, the feldspar forming more than half the mass in one part, while in another the augite and olivine predominate. By the action of the weather, the feldspar acquires an opaque white surface, upon which the black shining augite and the rusty-red decomposing olivine appear in strong contrast.

The dolerite of this mountain is traversed by numerous dikes, some of which are diorites like those of Monnoir and Belœil about to be described. A dike of compact dolerite, holding crystals of feldspar and grains of olivine is found intersecting the strata of the Hudson River formation at St. Hyacinthe.

Mount Royal.—This hill, which rises immediately in the rear of Montreal, consists for the most part of a mass of highly augitic dolerite. In some parts large crystals of augite, like those of Montarville, are disseminated through a fine-grained base, which is dark ash-gray in color, and often effervesces freely with acids from the presence of a portion of intermingled carbonate of lime. At other times this is wanting, and the rock is a mass of black crystalline augite, constituting a veritable pyroxenite, from which feldspar is absent. Mixtures of augite with feldspar are also met with, constituting a granitoid dolerite, in parts of which the feldspar predominates, giving rise to a light grayish rock. Portions of this are sometimes found limited on either side by bands of nearly pure black pyroxenite, giving at first sight an aspect of stratification. The bands of these two varieties are found curiously contorted and interrupted, and, as at Montarville, seem to have resulted from movements in a heterogeneous pasty mass, which have effected a partial blending of an augitic magma with another more feldspathic in its nature.

The more augitic parts of Mount Royal contain, like the similar varieties from Rougemont and Montarville, considerable portions of magnetite and some ilmenite. At the east end of the mountain a variety of dolerite containing olivine occurs. It consists of a base of grayish-white granular feldspar, which in the specimen examined constitutes about one half of the mass, and encloses crystals of brilliant black augite, and of semi-transparent amber-yellow olivine. This rock closely resembles the feldspathic peridotite of Rougemont, described above; but the imbedded crystals are somewhat larger, although less than those in the dolerite of Montarville. A portion of the feldspar, freed as much as possible from augite, furnished by analysis the result already given under XIX; which shows that it approaches labradorite in composition.

Diorites.

Yamaska.—It now remains to describe the diorites which have already been noticed as forming several important masses among the intrusive rocks of the Montreal group. In the first place may be considered that of Yamaska. The greater part of this mountain consists, as already described, of a micaceous granitoid trachyte; but the southeastern portion is entirely different, being a diorite made up of a pearly white crystalline translucent feldspar, with black brilliant hornblende, ilmenite, and magnetic iron. This rock is sometimes rather fine-grained, though the elements are always very distinct to the naked eye. In other parts are seen large cleavage surfaces of feldspar half an inch in breadth, which exhibit in a very beautiful manner the striæ characteristic of the polysynthetic macles of the triclinic feldspars. The associated crystals of hornblende are always much smaller and less distinct, forming with grains of feldspar, a base, to which the larger feldspar crystals give a porphyritic aspect. Finer grained bands, in which magnetite and ilmenite predominate, traverse the coarser portions, often reticulating; and the whole mass is also occasionally cut by dikes of a whitish or brownish-gray trachytic rock; which are often porphyritic, and may perhaps be branches from the trachytic part of the mountain.

A portion of the coarse-grained diorite selected for examination contained, besides the minerals already enumerated, small portions of blackish mica, with grains of pyrites and a little disseminated carbonate of lime, which caused the mass to effervesce slightly with nitric acid. The macled feldspar crystals, sometimes half an inch in length, were so much penetrated by hornblende that they were not fit for analysis; but by crushing and washing the rock, a portion of the feldspar was obtained which did not effervesce with nitric acid, and contained no visible impurity, except a few scales of mica; its specific gravity was 2·756—2·763. It was decomposed by hydrochloric acid, with separation of pulverulent silica; and its analysis, which is given under XX. and XXI, shows it to be near to anorthite, and identical in composition with the feldspar of a diorite from Bogoslowsk, in the Ural mountains. This is associated with a greenish-black hornblende containing some titanic acid, with a little mica and some quartz. (R. H. Scott, *L. E. and D. Philos. Magazine*, [4], xv, 518.)

Monnoir.—Monnoir, or Mount Johnson, is composed of a diorite, which, in its general aspect, greatly resembles that of Yamaska just described, except that it is rather more feldspathic. The finer-grained varieties are grayish in color, and exhibit a mixture of grains and small crystals of feldspar, with hornblende, brown mica, and magnetite. Frequently, however, the rock is

much more coarsely grained, consisting of feldspar grains, with slender prisms of black hornblende, often half an inch long and one-tenth of an inch broad, and numerous small crystals of amber-colored sphene. In this aggregate, there are imbedded cleavable masses of the feldspar, sometimes an inch long by half an inch in breadth. At the southern foot of the mountain, large blocks of the coarse grained diorite are found in a state of disintegration, affording detached crystals of feldspar with rounded angles, and weathered externally to an opaque white from a partial decomposition. Near to the base of the mountain, a coarse-grained variety of the diorite encloses small but distinct crystals of brown mica; and a fine-grained micaceous variety, containing sphene, occurs near the summit.

The feldspar, in all the specimens examined from this mountain, appears to be uniform in character. Its color is white, rarely greenish or grayish; it has a vitreous lustre, inclining to pearly, and it is somewhat translucent. The cleavages of this feldspar resemble those of oligoclase, with which species it also agrees in specific gravity and chemical composition. The macled forms, so common in the crystals of triclinic feldspars, have not however been detected in the specimens from this locality. A fragment of a crystal gave a density of 2·631, and another portion in powder 2·659. The results of its analysis are given under XXII. and XXIII.

	XX.	XXI.	XXII.	XXIII.	XXIV.
Silica,	46·90	47·00	62·05	62·10	58·30
Alumina,	31·10	32·65	22·60	....	24·72
Peroxyd of iron,	1·35		75	....	
Lime,	16·07	15·90	3·96	3·69	5·42
Magnesia,	·65	....	....	....	·91
Potash,	·58	....	1·80	....	2·74
Soda,	1·77	....	7·95	....	6·73
Volatile,	1·00	....	·80	....	·50
	99·42	....	99·91	...	99·32

Belœil.—The specimens which have been examined from this mountain consist of a kind of micaceous diorite. The feldspar, which so far predominates as to give a light gray color to the mass, is in white translucent vitreous cleavable grains; associated with small distinct prisms of black hornblende, scales of copper-colored mica, and grains of magnetite. The analysis of the feldspar, extracted by washing a portion of the crushed rock and still containing a little mica, is given above under XXIV. This result approaches to those obtained from the micaceous feldspar rock of Yamaska, V. and VI; which has been described as a kind of trachyte, and, with the rock of Belœil, seems to constitute a passage between the trachytes and diorites.

Rigaud.—A portion of Rigaud mountain consists of a rather coarsely grained diorite, which is made up of a crystalline feld-

spar, white or greenish in color, with small prisms of brilliant black hornblende, and crystals of black mica. In some specimens the feldspar, and in others the hornblende predominates. This rock resembles the diorites of Belœil and Monnoir.

The granitoid dolerites of the Montreal group, containing coarsely crystalline augite and olivine, break through the Lower Silurian strata; and portions of these two minerals, probably derived from these intrusive rocks, are found in the dolomitic conglomerates near Montreal, which in some cases include masses of Upper Silurian limestone, and are cut by dikes of a fine-grained dolerite. These, which perhaps correspond to the newer dikes of the same rock at Grenville, show that there were at least three distinct eruptions of dolerite,—one during the Silurian period, one before it, and another after it. The trachytes of Montreal and Chambly appear to be still more recent, and to traverse these newest dolerites.

The trachytes of Brome and Shefford seem to constitute a group apart; but the diorites of Yamaska and Mount Johnson, although similar in aspect, differ widely in chemical composition. Facts are still wanting to establish the geological age of these intrusive masses. The different dolerites, which are related in mineral composition, belong as we have seen to different geological periods; and it would not be safe to affirm that the different diorites or the different trachytes of this vicinity are contemporaneous. Nor, on the other hand, should even great discordances in chemical or mineralogical constitution be necessarily regarded as establishing a difference in the age of eruptive rocks. Evidence to the contrary of this is seen in the contiguous and intermingled masses of black pyroxenite and gray feldspathic dolerite in Mount Royal and Montarville; and it is not improbable that the olivinitic dolerite, which is associated with these, may be contemporaneous. If, as has been maintained in the first part of this paper, the various intrusive rocks are only displaced sediments of deeply-buried and probably unconformable strata, it will readily be conceived that plastic masses of very unlike characters may be ejected simultaneously along a line of disruption.

The various intrusive masses of the Montreal group which have here been described, appear, from their compact and crystalline structure, to have been displaced and consolidated under the pressure of a considerable mass of superincumbent strata. The fact that even their summits, which are in some cases more than 1000 feet above the present level of the plain, appear equally solid and crystalline with their bases, implies the removal by denudation, since the eruption of these masses, of a thickness of sedimentary strata much exceeding their present height. This denudation must however have taken place before

the eruption of the later trachytes and dolerites; since the dolomitic conglomerates, which enclose the fragments both of the olivinitic dolerite and of Lower and Upper Silurian rocks, repose unconformably upon the Laurentian and the various Lower Silurian strata, in such a manner as to show that these offered nearly their present distribution at the epoch of the deposition of the conglomerates. If then, as is probable, the exposure by denudation of the whole of the eight hills which have been described, took place at one epoch, these are all shown to have a greater antiquity than the trachytes and the dolerites which traverse the conglomerates. The fine-grained and earthy trachytes of Montreal are consequently far more recent than the crystalline ones of Brome and Shefford; with which, however, some of them agree in chemical composition.

The general absence of granite from among these intrusive masses is a fact worthy of notice. Quartz has not yet been detected in the feldspathic rocks of Brome and Shefford; although, as above mentioned, the base of the feldspathic porphyries of Chambly, and of Shelburne, contains a slight excess of silica. The granitic rocks of Shipton, and of St. Joseph on the Chaudière, appear to be indigenous masses, belonging to the strata of the Quebec group; but the higher fossiliferous formations to the east of the Notre Dame mountains, are traversed in various places by veins and great masses of intrusive granite, as in Stanstead, Barford, and many other places to the northeast, and along the frontier of Canada. It is worthy of note that the intrusive masses on the two sides of the mountain range are, so far as yet observed, entirely distinct in character; and that eruptive rocks are generally wanting among the Notre Dame mountains, which consist chiefly of stratified rocks. It is also to be remarked, that the intrusive granites at their eastern base are not unlike, in mineralogical characters, to the indigenous granites of the mountains; thus suggesting the view that these are possibly the source of the intrusive granites which break through the Devonian strata. A similar relation has been pointed out by Durocher, in Scandinavia, where the Paleozoic strata are broken by intrusive masses of granite, orthophyre, zircon-syenite, and diorite. These rocks, according to him, are specifically analogous to those of the underlying primitive gneiss, but petrographically distinct. (*Bull. Soc. Géol. de France*, [2], vi, 33.) These facts are in accordance with the theory of eruptive rocks developed at the commencement of this paper; and it would be easy to extend the comparison to the intrusive diorites and dolerites about Montreal, and to show their resemblance with the stratified feldspathic rocks of the Labrador series. (*This Journal*, [2], xxix, 283, and xxxi, 414.)

IV. Local Metamorphism.

In the second part of this paper I have asserted that the silicated minerals of crystalline rocks have a two-fold origin. In the first place, they may result from the molecular change of silicated sediments. These are either derived from the mechanical disintegration and partial decomposition of pre-existing silicates, or have been generated by chemical processes in waters at the earth's surface. In this way, steatite, serpentine, pyroxene, hornblende, chlorite, and in many cases garnet, epidote, and other silicates are formed by a crystallization and molecular re-arrangement of chemically-formed silicates, in a manner analogous to that in which mechanically-derived clays are converted into crystalline species. I have however pointed out that in the second place many of these silicated minerals may be generated by chemical reactions which take place among the mechanically mixed elements of sediments under the influence of heat aided by alkaline solutions. Both of these methods are involved in rock-metamorphism, and in the case of the local alteration of rocks by igneous masses, it is easy by comparative examinations to trace the chemical changes involved in the production of silicated minerals by the second method. In this way, Delesse has shown that in several cases, where the chalk of Ireland has been altered by the proximity of intrusive traps, the sand and clay which the former contains have been converted into calcareous silicates. (*Ann. des Mines*, [5], xii, pp. 189, 208, 212.)

An instructive example of this process is furnished at Montreal, where the bluish fossiliferous limestone of the Trenton group is traversed by dikes of dolerite, which are subordinate to the great intrusive mass of Mount Royal. The limestone for a distance of a foot or two is hardened, but retains its bluish tint. Within a few inches, it is changed to a greenish-white color, which is seen to be due to a granular mineral disseminated in the white carbonate of lime. The unaltered limestones from the vicinity contain variable amounts of insoluble argillaceous matters. A specimen treated with dilute chlorhydric acid, left a residue of about twelve per cent of a fine clayey substance, colored by a small amount of carbonaceous matter, and mixed with a little pyrites, which was removed by dilute nitric acid. This residue, after ignition, gave to a solution of carbonate of soda, 9·5 per cent of its weight of soluble silica; and the insoluble portion, being submitted to analysis, gave the result I. A portion of the limestone which was near to the intrusive rock, and was hardened and partially altered, was subjected to the action of dilute nitric acid, and gave an insoluble residue with the composition II. The more thoroughly altered greenish limestone was also treated with dilute nitric acid, which

dissolved the carbonate of lime, and left a residue, the analyses of which, from two different portions of the rock, are given under III. and IV.

	I.	II.	III.	IV.
Silica,	73·02	54·00	42·60	40·20
Alumina,	18·31	14·00	13·70	9·30
Lime,	·93	16·24	31·69	36·40
Magnesia,	·87	5·27	4·17	3·70
Protoxyd of iron,	traces	3·60	4·68	5·22
Potash,	5·55	3·14	undet.	undet.
Soda,	·89	1·22	"	"
Volatile,	....	90	1·20	1·20
	99·57	98·77	98·04	95·02

The residue from the unaltered limestone, including the silica soluble in alkalies, contains nearly 75·5 hundredths of silica, and 16·5 of alumina. These, in the vicinity of the dolerite, have become saturated with protoxyd bases, including the small portions of magnesia and of oxyd of iron which the limestone contains. This process evidently involves a decomposition of the carbonate of lime, and the expulsion of the carbonic acid. It is worthy of remark that while the unaltered limestone contains a little carbonate of magnesia, the rock from which III. was obtained yielded not a trace of magnesia to dilute nitric acid; II. marks an intermediate stage in the process, and shows moreover that the alkalies are still retained in combination with the aluminous silicate. These amorphous silicates, which have been formed by local metamorphism, might, under favorable circumstances, have crystallized in the forms of feldspar, scapolite, garnet, pyroxene, or some other of the silicious minerals which so often occur in metamorphic limestones. The agent in producing these silicates of protoxyds at the expense of the carbonates of the limestone, was probably a portion of alkaline salt, either derived from the feldspathic matter of the limestone, or possibly infiltrated from the contiguous feldspathic rock; whose elevated temperature produced the reaction which has resulted in thus altering this limestone.

Similar examples of local alteration are met with in several other places near to the intrusive rocks of the Montreal group. The schists of the Utica formation in contact with a dike of intrusive rock at Point St. Charles, and also near a mass of trachyte on a small island opposite the city of Montreal, occasionally exhibit small crystals of pyroxene, and in some cases prisms of hornblende. Among similarly altered shales at Rougemont are beds which consist of a highly ferriferous crystalline dolomite intermingled with dark-green cleavable hornblende, which forms thin layers, or in other cases encloses small rounded masses of the dolomite. (See for a description and analyses of this rock, the *Geology of Canada*, p. 634.)

At Montarville, the shales of the Hudson river formation are altered in the vicinity of the dolerite which forms the mass of the mountain. Some portions of the strata are very fine-grained, reddish-brown, and have an earthy sub-conchoidal fracture, with occasional cleavage joints. The hardness of this rock is not great, and it is apparently a kind of argillite, but between two beds of it is one of a harder coarse-grained rock, greenish-gray in color, and mottled with a lighter hue. This appears to be feldspathic in composition, and is penetrated in various directions by numerous slender prisms of black cleavable pyroxene, sometimes half an inch in length. The layers of sedimentation are distinctly marked in this bed, as well as in the finer grained strata which enclose it; and the whole affords an interesting example of the different effects of the same agency upon beds of unlike composition; although it would be impossible without comparative chemical analyses to determine whether the silicate which has here crystallized in the form of pyroxene, existed in the unaltered sediment, or whether, as in the case of the uncrystallized silicate from the altered limestone at Montreal, it had been generated under the influence of the intrusive rock. In by far the greater number of cases, the only apparent effect of the igneous rocks of the region under description upon the paleozoic limestones and shales, has been a very local induration; the appearance of crystals in these circumstances is a comparatively rare occurrence, and seems to depend upon conditions which are exceptional, showing, as I have elsewhere remarked, that heat and moisture are not the only condition of metamorphism. (*This Journal*, [2], xxxvi, 219.)

With these few examples of local metamorphism I conclude the present paper, proposing however to give in a subsequent one the results of some investigations of certain indigenous crystalline rocks.

Montreal, March 15, 1864.

ART. XVI.—*Description of a new species of Chiton;* by WILLIAM PRESCOTT, M.D., of Concord, N. H.

CHITON CALIFORNICUS.—The specimen of Chiton here described is in a dried state, having several years since been found cast upon the seashore at Santa Cruz Bay, California. It must, therefore, have been considerably larger when found than it now is. The color has also undergone a material change. It is said, when found, to have been of a uniform brilliant red: but now, the most prominent portion of the dorsal surface, (which would

naturally be the first to dry,) is mainly of a *chesnut-red*, while the sides, together with some irregular blotches on the back, are of a dark brown, approaching in many places to black—occasioned, no doubt, by incipient putrefaction previous to becoming dry.

The whole length of the specimen is 6·8 inches; greatest breadth, 3·1 inches; greatest perpendicular height, 1·7 inches. The *coat of mail*, or shell-like covering, which gives shape and form to the whole animal, is ovate-oblong, convex above, considerably narrowed before and much wider posteriorly. It consists of eight testaceous pieces, or valves, which are imbricate (over-

1.

Outline of 4th and 5th valves of *C. Californicus*, natural size.

lapping each other), with the extremities of their anterior wings deeply imbedded and concealed beneath the skin or mantle. *Valves* smooth, destitute either of lines of growth or geometrical markings and not carinated. A convex tubercle or prominence occupies the centre of the dorsal portion of each, being most prominent on the 2nd, 3rd, 7th and 8th, much less so on the 4th and 5th, while on the 1st and 6th it is in the form of an elongated ridge—on the former longitudinally, on the latter diagonally. (The latter may be accidental, or the result of an injury.) On the 7th and 8th valves the form is more perfectly mastoidal and more distinctly pointed.

The first, or anterior valve, is externally in the form of an obtuse V, with four deep narrow fissures at its anterior inner margin. The posterior or 8th valve is rounded externally, with a small emargination or circular notch at its posterior margin.

The shape of the six other valves is papilioniform, or butterfly-shaped, neither keeled nor beaked; posterior margin lunated, being deeply and circularly arched between two wing-like projections which extend backward, their rounded extremities overlapping the valve immediately behind. The anterior wings, which are much larger than the posterior, are rounded, and project forward beneath the valve immediately before it, forming an arch much deeper than that formed by the posterior wings, but not so regularly circular.

The whole exterior surface of the mantle, from the margin upward, is thickly besprinkled with minute granulations which are of the same color as the mantle, most numerous on the sides and resembling shagreen, less numerous on the back, and least of all on the convex tubercles. There are also numerous indentations, which are most numerous on the convex portion or back, giving it the appearance of having the granules removed by friction.

The *margin* is narrow, and, with the whole inferior surface, is coriaceous.

The gigantic size of the specimen and the peculiar and unique form and structure of its valves render it extremely interesting, and a full description and figure of it very desirable and highly important.

The name of *gigas* at once suggested itself; but as that name had already been given to an African species (although one much smaller than this), the name of *Californicus* (from the State upon whose shores it was found) has been adopted.

It was obtained in California, some 8 or 10 years since, by the Rev. O. C. Baker, of this city, in whose possession it still remains.

Concord, N. H., March 20, 1863.

ART. XVII.—*On the rising of Springs and Streams in California, before the winter rains;* by H. GIBBONS, M.D., of San Francisco.

IT is a subject of popular remark in this country, that the springs and small streams begin to rise a long time before the setting in of the rainy season, and before a drop of rain has fallen. The common notion is that the rise of the springs has some relation to the near approach of the rainy season. Although I had no doubt of the fact for several years, yet the demonstration of it did not occur to me until the autumn of 1858.

Two or three miles east of the Bay of San Francisco, and running parallel with the bay, is a range of hills about 1000 feet in height, the summits of which are naked, or sparsely occupied by oaks and redwoods. The springs and small streams, which abound on these hills in the winter and spring, mostly dry up in the course of the summer, though springs and swampy spots may be found here and there almost on the very summits through the whole course of the driest seasons. During the year 1858, I frequently traversed the hills by a road running in the trough of a crooked ravine, skirted by a pleasant little stream which started from a spring within two hundred yards of the summit and increased considerably in its descent. The dry season commenced rather earlier than common, not enough rain to lay the dust falling after the first week in April. My little rivulet continued to murmur refreshingly by the roadside until July, when it disappeared in places; and by the beginning of August it formed a chain of swampy spots and pools. At the end of August, when I expected to find it almost desiccated, judge of my surprise on encountering a brisk streamlet about a mile from the top of the hill, at a spot which had been perfectly dry. From that time it steadily increased, the pools being connected for the greater part by a continuous stream, by the 10th of October, though no rain had fallen.

Another instance still more striking has fallen under my notice. One mile from the foot of the hills, toward the bay, the county road is crossed by a small winter stream, never more than six feet wide, which became perfectly dry early in August. The channel of the stream is not more than two feet in depth. In the latter part of August, I was surprised to find in it a small pool of water, at the side of the road. On the fourth of September, the wet space extended some fifty feet. On the 9th of October, it had become a continuous, running stream, discharging five or six gallons per minute. And this happened without a drop of rain.

There is no great difficulty, I apprehend, in solving the phenomenon. The water which falls in the winter and spring penetrates the earth, and finds an impervious bed not far beneath the surface. This bed being more or less inclined, the water of course gravitates laterally, till it finds vent in the form of a spring. In the long days of summer, when the sun is fifteen hours above the horizon, and almost vertical, and when the atmosphere is very arid, evaporation is so rapid as to exhaust the supply at the springs and cause them to disappear; or at least to diminish the supply, and carry off entirely the water from the bed of the stream in the intervals of the springs. As the season advances, the days become shorter and the power of the sun also diminishes. Evaporation becomes proportionally slower,

and at length it is so retarded as not to carry off the percolations of the springs; and the springs first reappear, and then the streams.

The diminishing evaporation after the summer solstice may be forcibly represented by figures. Thus, the time occupied by the process of evaporation, in proportion to that of influx or replenishment—or, in other words, the number of hours of sunshine and of night, in this latitude, is nearly as follows:

June 20—	sun 15h.,	night	9h.;	or as	10 : 6.
July 20—	" 14h.,	"	10h.;	"	10 : 7·14.
Aug. 20—	" 13h.,	"	11h.;	"	10 : 8·45.
Sept. 20—	" 12h.,	"	12h.;	"	10 : 10.
Oct. 20—	" 11h.,	"	13h.;	"	10 : 11·82.
Nov. 20—	" 10h.,	"	14h.;	"	10 : 14.

But this exhibits only the space of time occupied by the evaporating process. The greatly diminished power of the sun's rays in the autumnal months enhances the effect very materially. Besides, it is quite possible that, in the longest days, when the soil is most heated, a portion of the water in the strata supplying the springs is drawn directly upward by capillary attraction. This would be an additional source of exhaustion, which would cease or diminish with the advance of the season.

I have been informed by the late J. W. Osborne, Esq., of Napa, that it is very common for the springs and streams, after rising in the autumn, to disappear again before the rains set in. Though this fact has not come under my own observation, yet I can scarcely doubt it, the cause is so obvious. We very seldom have rains sufficient to penetrate a foot into the soil before December. And though the evaporation may be almost completely suspended, yet the supply in the strata furnishing the springs must in time be exhausted, and in that case the springs would again disappear.

It is worthy of remark that, on sinking wells, water is found near the surface, in most of the plains and valleys of California. Impervious beds of clay or rock appear very generally to underlie the superficial strata. If it were otherwise, the phenomena to which this paper refers might not be so conspicuous. There is a prominent feature of the scenery of our plains dependent on the same cause. In the autumn, after travelling five or ten miles without meeting with a drop of water, or any growing vegetation, you observe a clump of green willows in the bed of what appears to be a "dry creek." You find there a pool of water, and perhaps in the course of the bed other pools will be found, where a good supply of water is always on hand in the driest seasons.

ART. XVIII.—*Notes on the New Almaden Quicksilver Mines;* by B. SILLIMAN, Jr.

THE New Almaden quicksilver mines are situated on a range of hills subordinate to the main coast-range, the highest point of which at the place is 1200 to 1500 feet above the valley of San José. Southwest of the range which contains the quicksilver mines, the coast-range attains a considerable elevation, Mt. Bache, its highest point, being over 3800 feet in height.

New Almaden is approached by the railroad running from San Francisco to San José, a distance of 45 miles. In the course of it there is a rise of 100 feet, San José being of this elevation above the ocean. From San José to New Almaden the distance is 13 miles, with a gradual rise of 150 or perhaps 200 feet.

The rocks forming the subordinate range in which the quicksilver occurs, are chiefly magnesian schists, sometimes calcareous and rarely argillaceous. As a group they may be distinguished as steatitic, often passing into well characterized serpentine. Their geological age is not very definitely ascertained, but they are believed by the officers of the State Geological Survey to be not older than Cretaceous. But few fragments of fossils, and these very obscure, have yet been found in these metamorphic rocks. At a point just above the *dumps*, behind the reduction works at the hacienda (or village), there is an exposure, in which may be clearly seen in projecting lines the waving edges of contorted beds of steatite and serpentine, interspersed with ochery or ferruginous layers, more easily decomposed; and the partial removal of the latter has left the steatitic beds very prominent.

The mine is open at various points upon this subordinate range over a distance of 4 or 5 miles, in a northeast direction. The principal and the earliest workings of the mine were in a right line, but little more than a mile distant from the hacienda. The workings are approached, however, by a well-graded wagon-road, skirting the edges of the hills, which is $2\frac{3}{8}$ miles in length.

It appears partly from tradition, and partly from the memory of persons now living, that the existence of cinnabar upon the hill was known for a long time prior to the discovery that it possessed any economic value. In fact, upon the very loftiest summit of this subordinate range, cinnabar came to the surface, and could be obtained by a slight excavation or even by breaking the rocks lying upon the surface. In looking about for physical evidences such as would aid the eyes of an experienced observer in detecting here the probable presence of valuable metallic deposits, one observes on the summit of the hill, at various points along the line of its axis for 2 or 3 miles, and also

beyond, toward the place called Bull Run, occasional loose boulders of drusy quartz, with more or less well characterized geodes and combs; accompanying which is an ochraceous or ferruginous deposit, such as frequently forms the outcrop of metallic veins. There is, however, no such thing as a well characterized vein, the quartz and its associated metals occurring rather in isolated masses or bunches segregated out of the general mass of the metamorphic rocks, and connected with each other, if at all, somewhat obscurely by thread veins of the same mineral.

The main entrance to the mine at present is by a level about 800 feet long, and large enough to accommodate a full-sized railroad and cars. This level enters the hill about 300 feet from its summit, and is driven into a large chamber, formed by the removal of a great mass of cinnabar, leaving ample space for the hoisting and ventilating apparatus employed in working the mine.

At this point a vertical shaft descends to an additional depth of nearly 300 feet, over which is placed a steam "whim" with friction gearing and wire rope, worked by a steam engine, and by means of which all the ore from the various workings of the mine is conveniently discharged from the cars, which convey it out of the level to the dressing floors.

The first thing which strikes the observer on entering the mine is the liberal scale of its exploration. Every thing indicates a liberal and judicious use of capital in the development of a property which upon any other principle of exploration would probably have been unremunerative. We note also the absence of the usual galleries or levels, cut at regular distances of ten fathoms, common in the exploration, for example, of copper mines, and of other metallic deposits in which the ore is confined to well characterized veins.

In order to reach the lower workings of the mine, the observer may employ the bucket as a means of descent, or he may, in a more satisfactory manner, descend by a series of ladders and steps, not in the shaft, but placed in various large and irregular openings, dipping for the most part in the direction of the magnetic north, and at an angle of 30° to 35°. These cavities have been produced by the miner in extracting the metal, and are often of vast proportions; one of them measures 150 feet in length, 70 feet in breadth, and 40 feet in height—others are of smaller dimensions; and they communicate with each other sometimes by narrow passages, and at others by arched galleries cut through the unproductive serpentine.

Some portions of the mine are heavily timbered to sustain the roof from crushing, while in other places arches or columns are left in the rock for the same purpose.

The principal minerals associated with the cinnabar are quartz and calcareous spar, which usually occur together in sheets or

strings, and in a majority of cases penetrate or subdivide the masses of cinnabar. Sometimes narrow threads of these minerals, accompanied by a minute coloration of cinnabar, serve as the only guide to the miner in re-discovering the metal when it has been lost in a former working.

Veins or plates of white massive magnesian rock and sheets of yellow ochre also accompany the metal. Iron pyrites is rarely found, and no mispickel was detected in any portion of the mine; running mercury is also rarely, *almost never*, seen.

The cinnabar occurs chiefly in two forms, a massive and a subcrystalline. The first is fine granular, or pulverulent, soft, and easily reduced to the condition of vermillion; the other is hard, more distinctly crystalline, compact and difficult to break; but in neither of these forms does it show any tendency to develop well formed crystals. It is occasionally seen veining the substance of greenish white or brown compact steatite or serpentine.

The ores are extracted by contract, the miners receiving a price dependent upon the greater or less facility with which the ore can be broken. By far the larger portion of the work people in the mines are Mexicans, who are found to be more adventurous than Cornishmen, and willing oftentimes to undertake jobs which the latter have abandoned. The price paid for the harder ores in the poorer portions of the mine is from $3 to $5 per cargo of 300 lbs. This weight is obtained after the ore is brought to the surface and freed by hand-breaking from the superfluous or unproductive rock; by this arrangement, the company are secured from paying for anything but productive mineral. All the small stuff and dirt formed by the working of the "labors," are also sent to the surface to form the adobes used in charging the furnaces.

It has often happened in the history of this mine, during the past fifteen years, that the mine for a time has appeared to be completely exhausted of ore. Such a condition of things has, however, always proved to be but temporary, and may always be avoided by well directed and energetic exploration. Upon projecting, by a careful survey, irregular and apparently disconnected chambers of the mine in its former workings in a section, there is easily seen to be a general conformity in the line of direction and mode of occurrence of the productive ore-masses. These are found to dip in a direction toward the north, in a plain parallel, for the most part, to the pitch of the hill, but at a somewhat higher angle. An intelligent comprehension of this general mode of structure has always served hitherto in guiding the mining superintendent in the discovery of new deposits of ore.

Since the settlement of the famous law-suit, which has so long held this company in a condition of doubt, the new parties, into

whose hands the property has now passed, have commenced a series of energetic and well directed explorations at various points upon the hill, with a view to the discovery of additional deposits of ore. At one of these new openings, distant at least 500 feet from the limit of the old workings, and not more than 200 feet from the summit of the hill, a deposit of the richest description of the softer kind of cinnabar has been discovered, which, so far as hitherto explored, has a linear extent of at least 70 or 80 feet, and in point of richness has never been surpassed by any similar discovery in the past history of the mine. A charge of 101,000 pounds, of which 70,000 were composed of this rich ore, 31,000 pounds of "granza," or ordinary ore, and 48,000 pounds of adobes, worth 4 per cent, making a total charge of 105,800 pounds, yielded on the day of our visit, 460 flasks of mercury at 76½ pounds to the flask. This yield is almost without parallel in the history of the mine. The only preparation which the ores undergo, preparatory to reduction, consists of hand-breaking, or "cobbing," for the removal of the unproductive rock.

The small ores and dirt hoisted from the mine are made into "adobes," or sun-dried bricks, sufficient clay for the purpose being associated with the ore. The object of these "adobes" is to build up the mouths of the furnaces to sustain the load of richer ores. No flux is employed, there being sufficient lime associated with the ores to aid the decomposition of the sulphurets.

The furnaces are built entirely of brick, in dimensions capable of holding from 60,000 to 110,000 pounds, according to the character of the ores employed. The chambers are fired from a lateral furnace, fed with wood, and separated from the ore by a wall pierced with numerous openings by the omission of bricks for that purpose.

Connected with the furnace is a series of lofty and capacious chambers, also of masonry, through which the whole product of combustion is compelled to pass alternately above and below, from chamber to chamber, until all the available mercury is condensed. The draft from these furnaces is carried by inclined stacks up to the top of a lofty hill several hundred feet distant; and here the sulphurous acid and other effete products of the furnace are discharged. Formerly, no precautions were taken to prevent the escape of mercury through the foundations of the furnace to the earth beneath: now, the furnaces stand upon double arches of brick-work, and plates of iron are built into the foundations, so as to cut off entirely all descending particles of the metal and turn them inward. To be convinced of the importance of this precaution, it is sufficient to watch the operation of the furnace for a few moments, when an intermittent

stream may be seen to flow into a reservoir provided for it, and which by the former process was completely lost in the earth.

On taking up the foundations of some of the old furnaces, within the last two years, the metal was found to have penetrated, or rather permeated, completely through the foundation and clay of the substructure down to the bed-rock beneath, a depth of not less than 25 or 30 feet. Over 2,000 flasks of mercury were thus recovered in a single year from the foundations of the two furnaces. This loss is entirely avoided by the improved construction which has been adopted.

The whole process of reduction is extremely simple, the time occupied from one charge to another being usually about seven days. The metal begins to run in from four to six hours after the fires are lighted, and in about sixty hours the process is completed. The metal is conducted through various condensing chambers by means of pipes of iron, to a "crane-neck," which discharges into capacious kettles. It undergoes no further preparation for market, being quite clean from all dross.

Deducting $2\frac{1}{2}$ years, during which the mines were in a state of inactivity, pending the decision of the law-suit, the average monthly product for $12\frac{1}{2}$ years has been not far from 2,500 flasks, of $76\frac{1}{2}$ pounds each, of mercury. The selling price in San Francisco is, at present, and has been for some time past, 75c. per pound, while in London and New York it has ranged from 40 to 50c. per pound.

San Francisco, May, 1864.

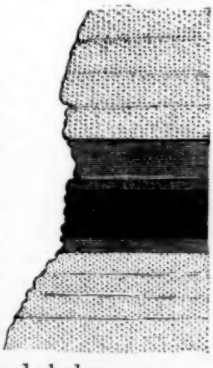
ART. XIX.—*Observations on a Seam of Coal;* by Prof. E. B. ANDREWS, Marietta College, Ohio.

THE seam of coal here described is located in the northern part of Washington Co., Ohio. It extends through the hills for several miles, and is generally of workable thickness. On Bear Creek, a small tributary of the Muskingum river, which latter stream is rendered navigable by large dams and locks, the coal is five feet in thickness. To the south the coal disappears, and evidence will presently be given to show that the original coal marsh was in that direction, skirted by open water. The geological position is near the top of the Coal Measures. I know of no other seam of coal of economic value above it in our Ohio rocks, although we find perhaps two hundred feet of unproductive sandstones and shales still higher. It is about sixty feet higher in the series than a peculiar group of limestone strata, with which is associated a seam of coal now worked at Coal Run on the Muskingum river. This group is very persistent, and, after showing itself over a considerable part of Washington

County, dips below the Ohio river to the northeast and reappears in the vicinity of Wheeling, W. Virginia, where its accompanying coal is extensively mined. In this connection it may be remarked, that there is great confusion among our geologists relative to the equivalency of the Pittsburg, Wheeling, and Pomeroy seams of coal. Dr. Caleb Briggs, who was connected with the early surveys of Western Virginia and Ohio, regards the three seams as equivalent; while Lesquereux makes the Pittsburg and Wheeling seams equivalent, to which he adds another, in a seam of coal at Athens, Ohio. My own investigations have led me to believe the Wheeling and Pomeroy seams to be entirely distinct, while the Athens coal is probably the continuation of the Pomeroy seam. The Athens coal is probably the same with the Federal Creek Coal, (Athens Co.) which, by all our Ohio geologists, is regarded as the continuation of the Pomeroy seam. The Pomeroy seam, as traced by myself, from Federal Creek into the northwestern part of Washington County, is found to be from sixty to seventy feet above the very limestone group which is so persistent, and which carries with it the Coal Run and Wheeling seam of coal. The Pomeroy seam sweeps around through the northern and eastern parts of Washington County, and is everywhere from fifty to seventy feet above the limestone group. Doubtless the seam of coal which is found in the hills above the Wheeling seam at Belleair (near Wheeling), is the equivalent of the Pomeroy coal.

The Bear Creek coal, which I propose to examine, is without doubt the geological equivalent of the Pomeroy seam. It is, however, greatly modified in structure by causes which I shall hereafter explain. Before the Bear Creek coal disappears to the south, there is evidence of a struggle in that direction between the vegetation and the water. The coal-marsh was repeatedly flooded, and over the vegetation thick deposits of sediment were made which are now fire-clay. We have these repeated alternations of coal and clay until, at last, the coal disappears, and we reach a region of unbroken water. There is nothing peculiar in the rocks associated with this coal.

1.



Above the coal is a thin stratum of bituminous slate. Above the slate several feet of fire-clay, and above the clay a heavy sandrock. Below the coal is fire-clay, and below that a considerable development of sandstones and shales.

The coal was analyzed by Dr. J. S. Newberry and gave:

Volatile matter,	49 to 51 per cent.
Fixed carbon,	44 " 46 " "
Ash,	3 " 5 " "

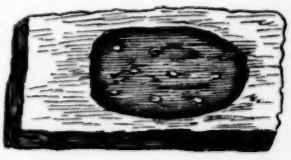
Probably this percentage of ash is a little below the average for the whole seam. The coal is hard, and breaks with an unusual conchoidal fracture, resembling cannel coal. The appearance of the laminations as seen on the surface of the polished vertical planes, resembles varnish spread with a coarse brush, thus giving a peculiar streakiness to the surface. These laminations often show themseves to be immeasurably thin layers of sedimentary matter. In the fracture these layers present the appearance of exquisitely-fine steel medal-ruled engraving. It is doubtless to these peculiar laminæ that the coal owes the property of parting with remarkable readiness with its gas or hydro-carbons, for the coal is very rich in gas and burns with remarkable freedom. In the grate it differs from the Wheeling coal, as dry wood differs from wet green wood. Why the presence of these laminæ of sedimentary matter—thinner than any tissue paper—should thus facilitate the production of gas, a fact which I have observed in some cannel coals, has not been explained so far as I know. Besides these peculiar laminations, there are the usual ones, which most geologists regard as produced by the different increments of vegetable matter, and showing perhaps periodicity in the growth and falling of the leaves and fronds of the coal vegetation. The Pittsburg coal exhibits this class of laminations in smooth and highly polished horizontal surfaces, and it is by these that this coal is readily distinguished from other Western coals. In the Bear Creek coal we find also laminæ of mineral charcoal. This is sometimes found in plates one-fourth of an inch in thickness. It exhibits a fibrous, woody structure, and is very soft and easily reduced to powder. Whether this charcoal is produced by some peculiar property in the original vegetable matter, which did not permit the usual bituminization, or the bitumen has been subsequently removed by great pressure, leaving the fibres dry like the pressed stalks of sugar cane, it is perhaps impossible to determine. The first class of laminæ, those having a sedimentary appearance, doubtless tells a tale of water, and indicates that the vegetation grew where it was very marshy and constantly inundated. This water, however, contained only the slightest possible amount of impalpable sediment, and could scarcely have been much discolored. This marshy character of the coal field and the overflow of water doubtless caused an unusual softening and maceration of the fallen vegetable matter, and produced the cannel-like character of the coal. But while the coal marsh was ordinarily more or less covered with comparatively pure water, at one time it

LIBRARY OF THE UNIVERSITY OF MICHIGAN

was flooded by more turbid water, which left a distinct earthy deposit. This thin slaty streak in the coal, now black and highly bituminous, is evenly distributed over a large area, and indicates a general overflow.

Another interesting feature of the Bear Creek coal is the presence, in various parts of the seam, of drifted and beach-worn wood. This is generally found in small fragments with the ends rounded, as if long water-tossed. Though now changed into sulphuret of iron, they show plainly a woody structure, and are entirely unlike the flat plates of sulphuret of iron which are formed within all coals by chemical affinity. I have found them showing the bark-markings of the original tree.

2.



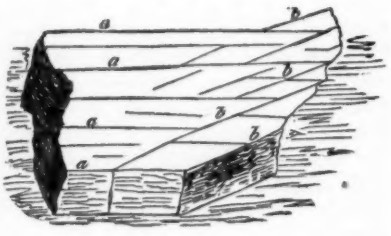
In some instances they are sticks six or eight inches long, an inch and a half in diameter, and rounded at the ends. They are not confined to any particular part of the seam, but may be met with any where, even in the very purest portions of coal. This would indicate that the coal was formed under circumstances allowing these vegetable waifs to be floated in and lodged among the vegetation. But the water on which they were borne could have been only slightly charged with sediments, as no such sediments, with the exceptions of the extremely thin laminæ previously alluded to, are found in the coal. I doubt whether these bits of drifted wood are to be found in the coal very far inland from the water edge of the coal marsh. I have not noticed them in the same seam of coal where it is mined, a few miles northeast of Bear Creek. There is, moreover, evidence to show that the coal changes in character as it recedes from the water's edge of the original marsh. It becomes more soft and caking, and less like cannel in fracture and behavior in the fire. These facts are interesting, as tending to verify Dr. Newberry's theory, that cannel coal is produced by the action of water in rendering the vegetable matter more soft and pulpy.

Vertical planes.—The existence of vertical planes in all coal has long been known. I have improved many opportunities of studying these planes, and have, so far as our Western coal fields are concerned, verified a conclusion which I presented in a paper read before the American Association for the Promotion of Science, at the meeting in Springfield, Mass., viz: that these planes have a uniform direction—nearly east and west. I have examined seams of coal in all parts of the Coal Measures, from the bottom to the top, as well as seams far apart geographically, and have invariably found the general direction of these planes the same. So confident have I become in this conclusion, that,

in my geological rambles among the hills and mountains, I have often taken my points of compass from the coal, as I have found the seams exposed in the various hillsides.

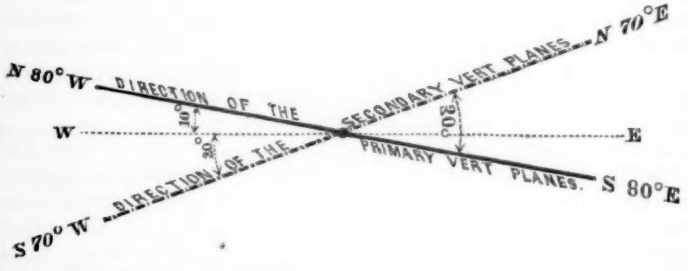
In the Bear Creek coal the principal planes lie in the direction S. 80° E. Besides these principal or primary planes there are local developments of other planes, which make an angle with the first. The secondary planes are parallel with each other, and constitute at the point where exhibited a perfect and beautiful system, and as distinctly marked as the primary system. The accompanying figure, (fig. 3,) shows the systems of planes in a block of the Bear Creek coal. The lines marked *a* represent the primary planes; those marked *b* the secondary ones.

3.



In very rare instances the plane *b* curves into the plane *a*, but generally there is a sharply defined angle of intersection. These angles vary in different localities in the same mine; but wherever the secondary planes appear, they are parallel and true to their own local system. The highest angle I have measured is over 30°, but generally the angles are less. So far as I have examimed the Bear Creek coal, the secondary planes cross the primary ones in the direction of south-of-west and north-of-east. This brings the primary planes on one side of the east and west line, and the secondary planes on the other (see fig. 4). If these

4.



may be called crystalline planes, as their regularity and polish would indicate, they were doubtless formed at the time of the solidification of the coal, and their direction determined by terrestrial electricity. The great east and west currents of thermal electricity might induce a sort of polarity in the particles of coal,

causing them to part in the magnetic directions north and south. The presence of iron in the coal might have facilitated this action. The divergence of these planes from an east and west line are not greater than the aggregate secular variations of the needle, and may have been produced by the same cause. That these planes are entirely unlike slaty cleavage and jointed structure, seen in other rocks, is, I think, sufficiently apparent. There are no such planes, nor jointed structure of any kind, in the bituminous slates and shales accompanying the coal. A thin lamina of coal, not thicker than paper, shows these planes perfectly, while nothing of the kind is found in the bituminous slate above and below. There is no jointed structure to be found in any of our rocks associated with the coal. So far as I have observed, these joints are generally found in rocks which have been subjected to heat as well as pressure. If this is so, we should not expect such joints in the coal; as in the West, it has never been subjected to any heat, the coal still retaining its full and normal quantity of bitumen.

Other lessons may be learned from this seam of coal, but I defer their consideration to another time.

ART. XX.—*On the Chimenti Pictures;* by CHARLES A. JOY, Professor of Chemistry in Columbia College, New York.

PHOTOGRAPHS of the famous Chimenti drawings have been exhibited in this country, upon the back of which was pasted the following announcement:

"The stereoscopic pictures executed by Jacopo Chimenti, born 1554, died 1640. These remarkable pictures, from the Museum Wicar at Lille, were found to be stereoscopic by Dr. Alexander Crum Brown, when visiting that city in 1859 with his brother, Dr. John Brown. Sir David Brewster communicated this curious discovery to the Photographic Society of Scotland, and Dr. Brown's account of it was published in the Photographic Journal of May 15, 1860, and in the Encyclopedia Brittanica, article Stereoscope.

In these works, Sir David Brewster expressed the opinion, that as Baptista Porta had, in 1593, published (after Galen, born A. D. 130,) the true principle of the stereoscope,[1] Chimenti had executed the drawings from the binocular principle of Porta, and was therefore the true inventor of the ocular stereoscope.

In order to satisfy himself of their stereoscopic character, Sir David applied for a photograph of them, but failed in procuring it. Mr. Wheatstone, however, having obtained one, declared

[1] See his Treatise on the Stereoscope, pp. 6 and 8.

that *the pictures were not stereoscopic;* and Dr. W. B. Carpenter, being of the same opinion, charged Sir David Brewster publicly with dishonesty, in not having retracted his opinion of them, alleging that he must have known that they were not stereoscopic from copies in his possession. Sir David never saw the pictures till March 7, 1862, when he received a photograph of them from Professor Kuhlemann, of Lille, and found them to be *truly stereoscopic!* Mr. Wheatstone and Dr. Carpenter *apparently* not knowing that they should be *transposed* when placed in the stereoscope, though this is distinctly shown in Dr. Brown's communication."

The authorship of the above history of the Chimenti pictures is usually attributed to Sir David Brewster.

Prof. Emerson, in the following note, has again called my attention to these prints, being impelled thereto by an article from Sir David Brewster in the Philosophical Magazine:

"Paris, Feb. 24, 1864.

To Professor Joy, Vice-President of the Am. Photographic Society:

My Dear Sir:—As I know your lively interest in such matters, you will probably have noticed a letter of Sir David Brewster in the Philosophical Magazine for January, 1864, in which he controverts the conclusion I draw from my investigations of the Chimenti Pictures.[2] It is my intention to reply to this letter of Sir D. Brewster; but as an important element in the final settlement of this scientific controversy is the testimony, on the point in dispute, of persons skilled in stereoscopic investigation, it is my opinion that you would render valuable aid to the cause of optical science if you would collect and publish, in Silliman's Journal, American testimony on this subject. You will greatly oblige me by undertaking this investigation, especially as I know you will do it thoroughly and exhaustively.

I am very sincerely yours, Edwin Emerson."

In compliance with Professor Emerson's request, I have been at some pains to obtain American testimony on the matter in dispute.

Three sets of the Chimenti pictures were pasted on stereoscopic cards. The first set was mounted correctly according to Sir David Brewster; the second, as they were found, that is, wrong, according to Sir David; on the third, two prints from the same negative were placed side by side. These prints were sent to persons familiar with the use of the stereoscope, and a large amount of testimony was obtained. Truth compels me to say that not a solitary person found them to be "truly stereoscopic."

A few observers imagined that they saw some slight relief; but as they pronounced the relief to be best where the right and left hand prints were from the same negative, their testimony was unfavorable to Sir David Brewster.

[2] This Journal, Nov. 1862.

When photographs of the Chimenti drawings were first sent to this country, they underwent a thorough and searching scrutiny; the verdict was unanimous against Sir David, and all were at a loss to account for the pertinacity with which that distinguished observer adhered to his opinion.

Out of the mass of testimony which was cheerfully furnished to me, I have made a few selections.

Professor William B. Rogers, of Boston, whose opinions upon questions in physical science rank as high as those of any man of science in this country, has sent me the following valuable suggestions, which I publish at length upon my own responsibility, as the writer has gone to Europe and cannot be applied to for his consent.

Prof. Rogers writes: "I will state the impression gathered from a hasty scrutiny made both without and with the stereoscope.

It is simply this; that the difference between the two pictures is such in kind and degree as might easily arise from imperfect or careless copying, and furnishes to my mind no evidence of having been designed for stereoscopic effect. In my own attempts to draw simple figures in pairs as nearly alike as I could make them without measurement, I have rarely succeeded in producing twin pictures which on combination did not present more or less relief. An expert draftsman could doubtless reproduce a drawing so closely as to avoid any *decided* effect of this kind; but if careless even to the extent of a very slight change of direction of some of the lines, his copy, however generally true, would not fail, on combination with the original, to exhibit decided stereoscopic relief. It is needless to remind those who are practiced in binocular combination, of the exquisite test which it affords of the slightest deviation from identity in the drawings combined.

I have now before me two copies made by a young friend from one of the photographs which you sent me, in which she endeavored to reproduce the original as exactly as she could, without resorting to measurement. On combining them with the eyes or with a stereoscope, they furnish a picture quite as clearly and strongly stereoscopic as the twin Chimenti pictures.

I should add, that although ready with the pencil, my friend has but small experience in the use of it.

It seems to me that until some clear proof is furnished, independent of the Chimenti pictures, that the stereoscope was known at the time they were drawn, the stereoscopic availability of these pictures may most reasonably be attributed to accident, and can hardly weigh as evidence that the instrument had then been discovered.

Such are my impressions from a brief examination of the

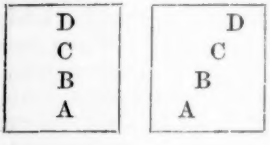
photographs; but the opinion of Sir David Brewster, who has studied the drawings critically, and who is so distinguished for knowledge and experience in this department of enquiry, makes me hesitate in adopting a conclusion to which he is opposed."

Another authority writes: "To my eye they are as lacking in all stereoscopic effect as would be two *straight lines*, or a sheet of paper pasted on the wall. I venture no opinion as to what they were intended to be, only as to what they are."

Another gentleman very familiar with the subject, says: "There is not the remotest approach to stereoscopic effect. There are slight differences between the two, but not of the kind which usually exists between stereoscopic pictures. One is evidently a copy (and carelessly done) of the other. The positions of the figures differ. In one the head is raised higher than in the other. The same figure is $\frac{1}{32}$ of an inch *taller* than the other, and the bench it sits on stands level, while in the other it is tipped downward. There are many such differences, which prove conclusively that they never were intended for stereoscopic effect. In the stereoscope it is impossible to make these differences coincide."

In a paper "On a method of producing stereographs by hand,"[3] Professor Rood has shown that where we "adopt the left hand picture as a standard of comparison, we find that the right hand picture is an exact reproduction of it, with one important exception, viz: that in the right hand picture the position of an object a little more distant from the spectator than the immediate foreground, is shifted a small distance toward the right hand; objects farther back have their position shifted still more to the right hand.

This is illustrated by fig. 1, where A is in the immediate foreground and D in the background."



The bulk of the variations in the Chimenti pictures are not to the right or left, but up and down. If these differences were designed by the artist to produce what we now term stereoscopic effect, they fall short of the intent. They produce a slight blur on the pictures when we attempt to combine them; so that a majority of persons find the best effect with the Chimenti pictures when two prints from the same negative are presented to their observation: while experts denounce the whole thing as an attempt to practice upon their credulity.

In some of the paintings by Teniers of a chemist in his laboratory, can be seen apparatus highly suggestive of a spectroscope. We trust that no future Dr. Brown will announce that the spec-

[3] This Journal, [2], vol. xxxvi, 71, Jan., 1861.

troscope was so well known at the time of Teniers as to be included in the inventory of apparatus of a chemist's laboratory.

Is not the evidence that the theory of binocular vision and of the stereoscope were known at the time of Chimenti, quite as weak as would be afforded by Teniers' pictures, to disprove the modern invention and use of the spectroscope?

The Chimenti pictures must therefore be ruled out of court and judgment entered for Mr. Wheatstone, unless new evidence can be found worthy of the consideration of scientific men.

New York, June 1, 1864.

ART. XXI.—*Results of some recent Observations of the Solar Surface, with Remarks;* by the Rev. W. R. DAWES.[1]

DURING nearly the whole of last year and the first three months of this, the state of the air was rarely sufficiently good to permit a successful scrutiny of the solar surface with high powers on a large telescopic aperture;—on such occasions, at least, as I was able to make much use of. But on three or four days in April I found that vision was remarkably steady and distinct, and I improved the opportunities to the utmost.

As it was of considerable importance that the same minute portions of the surface should be examined and compared together under various magnifying powers, and with different shades of dark glass, I preferred, after a careful comparison with the ordinary eye-pieces and an excellent transparent diagonal, to employ a solar eye-piece of my own construction. And I would take this opportunity of correcting an idea which has been advanced, that the diffraction of the rays at the edge of a small aperture in that eye-piece interferes with the distinctness of the object viewed. Close to the edge of the field there is, of course, as Mr. Huggins well expressed it at the last meeting of the Society, a narrow ring of diffracted light: but the breadth of this ring does not, I think, exceed 2″ on my telescope; and the smallest aperture in the diaphragm-plate has a diameter of 15″. Consequently, there is a central space of at least two-thirds of the diameter in which the definition is perfect, even in the smallest aperture of the eye-piece. Yet, for the purpose now referred to, I rarely use a field of much less than *one minute* in diameter; and any object not exceeding 45″, when placed in the centre of the field and kept there by the driving-clock, is recognized with certainty under different powers, and seen with the utmost possible distinctness.

1. One of the objects I had principally in view was, to ascer-

[1] Monthly Notices of the Royal Astronomical Society, May 13, 1864.

tain whether in any part of the photosphere any objects could be found which could reasonably be compared to "willow-leaves" (as called by Mr. Nasmyth) in their form.—It may be well to state here that I have always found it difficult to devise any appropriate appellation for the small bright irregularities of the surface, which would avoid an assumption of their character, or ascribe to them a regularity of form they do not possess. In my first paper I expressed my strong objection to any *name* of this kind, as calculated to convey an erroneous impression. The term *willow-leaves* seemed utterly inapplicable to anything I had ever succeeded in discovering. A far less objectionable term, as it appears to me, is that of *rice-grains* applied by Mr. Stone to those objects with which all careful Sun-observers must be acquainted, as there is no difficulty in seeing them in a moderately favorable state of the air, and which have been familiar to myself for many years;—so much so, indeed, that when they were not discernible I invariably abstained from any further scrutiny of the solar surface as being useless. Yet even this appellation conveys the idea of uniformity of shape and size which these objects do not possess, and is, I think, on that ground, objectionable. But I have been led by it to apply the term *granulations*, or *granules*, which assumes nothing either as to exact form or precise character; and I venture to hope that the term will be generally adopted.

To proceed then with the results of my recent observations.

Various portions of the surface were diligently examined with powers from 131 to 407. The bright little granulations were easily seen in all parts not very near the edge of the disk. Their forms and sizes were carefully noted, and found to be so various as to defy every attempt to describe them by any one appellation or comparison. But, as I have observed in a former communication, the rarest of all forms was the long and narrow; and in no instance did I succeed in finding one which could with propriety be compared to a willow-leaf. Occasionally, some that were nearly in contact differed so greatly in size that one was four or five times as large as the other; and while, in a remarkably bright mass, one somewhat resembled a blunt and ill-shaped arrow-head, another, very much smaller and within 5″ of it, was an irregular trapezium with rounded corners. The more quiet and perfect the views I obtained of them, the more convincing did the evidence appear that they were not individual and separate bodies of a peculiar nature, but only different conditions as to brightness or elevation of the larger masses forming the mottled surface; just as the brighter portions of that surface, and the *faculæ* also, are different conditions of the general photosphere. In these researches I met with nothing which had the slightest resemblance to the *interlacing* which Mr. Nas-

myth has so clearly described and so distinctly depicted in his communication to the Manchester Literary and Philosophical Society; of which letter I was not aware when I penned my former paper on this subject. Mr. Nasmyth having subsequently favored me with a copy, I was so struck with the clearness and decision of his assertions that I began to think I must have overlooked the peculiar appearances of the objects which he has depicted in his diagram as being "*the exact form of these remarkable structural details*," which he describes as "*forming the entire luminous surface of the Sun;*" and, therefore, to leave nothing untried, I collected all the information I could as to the means employed by him and by other observers who had seen something of the same kind, in the hope that some change in my apparatus or mode of using it might at length render me successful. Now, however, it appears that Mr. Nasmyth has withdrawn his former statements as to the exact and uniform figure of the objects he claimed to have discovered on the entire surface; and that, in fact, all that might have been regarded as a *discovery* resolves itself into an appearance perfectly well known many years before.

The darker or shaded lines between the granules I distinctly observed in many places to be pretty thickly covered with dark dots, like *stippling with a soft lead-pencil;* and these are what have been called "*pores*" by Sir John Herschel, and "*punctulations*" by his father. Some of these were almost black, and looked like excessively small spots just breaking out. But none of them were seen to enlarge or materially alter their form, though at times so sharply defined with powers 276 and 407 that it was obvious they were in general not quite round.

It appears to me quite incomprehensible that, under such definition, any bright objects of peculiar form should have escaped detection when specially looked for; and I was certainly struck with the extreme rarity of a long and narrow shape among the hundreds of granules which I examined in those four days' observations. If therefore there are any willow-leaf-shaped objects to be seen, they must be quite distinct from these granulations, and can form no regular or usual ingredients in the composition of the solar surface.

On the *penumbræ* of the spots then visible I found several long and narrow bright lines, extending like bits of white thread completely across the whole breadth of the penumbra without any break whatever; and, though there were several smaller pieces, not one of them would have suggested to my mind the comparison with a willow-leaf. Perhaps the bright granules of the general surface may sometimes be compressed into a longer form under the influence of the same forces which produce the longer threads or *straws* on the penumbra; but one of the most striking features of that part, as well as of the general surface, is,

according to my observations, the entire absence of uniformity in the brighter portions with respect both to their size and shape.

2. A second object of my investigations was to determine whether the granulations existed equally in the brightest and in the less luminous portions of the surface, which together form the general and comparatively *coarse* mottling of the photosphere.

On comparing together in the same field of view several of the more and less luminous masses which produce the coarse mottling of the surface, I came to the conclusion that the granules are generally *larger* as well as brighter on the brightest parts than on the darker; the difference in brightness of the individual granules in each part being much the same as in the different masses themselves. One fact struck me as very remarkable, that, on each of these larger masses, the individual granules are all very nearly of *equal* brilliance throughout the mass to which they belong. They are not in general, if ever, mixed together, some much brighter and others far less bright on the same mass. Occasionally I have noticed that some of the brighter masses are decidedly brighter than others of the same class, and that such have extended to a much greater length than usual. The granulations on them are also generally, I think, of uncommon size, and the shaded lines between them of a ligher tint. I strongly suspect that these specimens, if near the Sun's edge, would be seen as *faculæ*.

3. A third principal object I had in view was, to scrutinize especially the brighter parts immediately surrounding the penumbræ of spots (which in a former paper I have referred to as indicating a heaping up of the photosphere by some eruptive force proceeding from the centre of the spot), with the purpose of ascertaining whether the granulations elsewhere easily visible were to be found there; and also to examine the *faculæ* of various forms, sizes, and degrees of brightness, to determine whether any such granulations were visible upon them.

With reference to the reality of this brighter region surrounding all the considerable *profound* spots, and also some of the smaller ones, I have lately been much gratified by the corroboration of the fact afforded by some solar photographs taken by our President, and obligingly presented to me since the publication of my former paper. While the general mottling of the surface is well brought out in them, they show that this mottling never extends to the margins of the spots; which precisely agrees with my observations. In this locality I have never been able to detect any of the granulations so abundant and so easily seen elsewhere. My recent observations fully confirm the conclusion I have formerly arrived at, namely, that the commotion, of whatever kind it might be, had produced the effect of heaping up the material of the photosphere; and had confounded all

the distinctions elsewhere seen of the large brighter and shaded masses, and also of the granulations on both, and the pencil-lines, occasionally stippled, by which the individual granules are distinguished.

Precisely the same results attended my examinations of the *faculæ*. Nothing resembling granulations could be found on any of them, whether they were the tortuous, thread-like objects seen near the east and west borders, or the shorter lumps of apparently similar composition near the poles. Yet the granulations were discernible in several places nearer to the Sun's edge than the faculæ were situated; so that it could not arise from the obliquity of the view that they were not visible on the faculæ themselves. I conclude, therefore, that the same disturbance which produces the elevated ridges confuses the minute features elsewhere seen; and that, though there may be some traces of granulation when the faculæ are viewed almost perpendicularly, yet this is entirely lost when their sides only are seen near the Sun's limb. In this position, however, there are often distinct evidences of irregularity in the elevation of different parts of the ridge; and these may, perhaps, when viewed perpendicularly, produce variations of brightness, like the granules of extraordinary size mentioned above.

Hopefield Observatory, Haddenham, Bucks, May 9, 1864.

ART. XXII.—*On Molecular Physics;* by Prof. W. A. NORTON.

[Continued from p. 78.]

IN considering the changes of state through which the same substance may pass, we have been led to recognize as an important physical principle upon which the mechanical properties manifested in each new condition in a great degree depend, that the physical condition of the individual molecules is liable to permanent variations from the effect of heat; and that these variations consist in expansions of the electric atmospheres which surround the atoms of the molecules. If we take a more extended view, and consider the diverse permanent changes of condition which the same substance may experience, while in the same state of aggregation, we may discern the operation of of a still more comprehensive principle; viz., that the physical state of the atmosphere of a molecule, and therefore the curve which represents its action upon surrounding molecules, is liable to permanent alteration from the action of external forces generally. It is well known that if a mechanical force, of considerable intensity, be applied for a short interval of time to a body, the result will be a permanent change in its form. The experiments of Hodgkinson have indeed established that a certain set may be imparted to bars of cast iron, by a temporary load

which is but a small fraction of its breaking load, and that "there is no weight however small that will not injure the elasticity" of such a bar. As we cannot suppose that a given mass of molecules, while retaining forces of mutual action of unvarying intensity, can take up an infinite number of positions of equilibrium, differing but slightly from each other, we must conclude that the individual molecules experience some change of condition, which occasions a change in the intensities of the forces they exert in a given direction.

From our present theoretical point of view, such possible changes of condition consist in compressions, or expansions, of the molecular atmospheres; either as a whole, or unequally on different sides. In the former case there will be a variation in the size of the atmosphere, and in the intensities of the forces of attraction and repulsion exerted by the molecule at a given distance, but the forces exerted in different directions will have an equal intensity. In the latter case there will be a variation in the form of the atmosphere, and an inequality of action in different directions. The form assumed will be spheroidal, or approximately so, supposing it to have been originally spherical; and the mechanical result will be the exertion of an increased force of attraction from the sides of the molecule at which its atmosphere is compressed, and a diminished force from the sides at which the atmosphere is expanded. This follows, as a necessary consequence, from the fundamental conception of molecular forces, developed on pages 68 to 71; as may be distinctly seen by attending to the values of $\frac{n}{m}$ and r. It will thus be seen that the molecular atmospheres, in assuming the spheroidal form, under special circumstances, determine the existence of molecular axes of cohesive attraction, "whose force is inversely related to their length." In the direction of such axes, then, the limit of stable equilibrium ($O\alpha$, fig. 1, p. 71) will be least for the shorter axis, and greater for the longer axis.

When a force of pressure applied to a body determines a permanent compression, the molecular atmospheres remain compressed, or in closer proximity to their central atoms, and the force of cohesive attraction is permanently increased, and the limit of stable equilibrium diminished. The heat developed is a necessary result of the compression of the atmospheres. If the elastic reaction to the pressure after it is withdrawn, were perfect, the atmospheres would resume their original form and dimensions, the original molecular forces would be recovered, and the heat evolved would be absorbed again. In general when mechanical forces are applied to a body, the heat evolved, or absorbed, is a necessary accompaniment of the compressions, or expansions, superinduced in the atmospheres of the particles, and may be

regarded as a sensible indication of the extent of such changes of molecular condition. The mechanical work, of which the heat evolved serves as the measure, is expended in urging the atmospheres nearer to their central atoms.

On the other hand, if heat be directly applied to a body, it has a tendency opposite to that of a mechanical pressure, or to expand the molecular atmospheres, and so to reduce the intensity of the cohesive attraction, at a given distance. It is to be observed, also, that heat has a tendency to dissolve the groups in which the particles of a solid may be aggregated; and when the point of fusion is reached, will effectually break up such groups, and bring the mass to the condition of a homogeneous and symmetrical arrangement of molecules.

Solidification, or Crystallization.—It is a well recognized principle that solidification and crystallization are the same process. This great principle was first propounded by the learned and acute Dr. Young in 1807, in his lectures on Natural Philosophy. It has also been advocated by Biot and other physicists; and more recently has been reasserted and ably sustained by Professor Dana, in his admirable paper on Cohesive Attraction, published in vol. iv, second series, of this Journal. If now it be admitted that solidification is in every instance but a more or less perfect crystallization, it will be perceived that the investigation of the mechanical process of crystallization must consist essentially in an inquiry into the conditions and results of the operation of the molecular forces under special circumstances. The general nature of these forces, and the laws of the variation of effective molecular action with the distance between two molecules, have already been under discussion. We have also seen (pp. 207, 208) that the mechanical condition of an individual molecule is subject to change under the operation of heat, and external forces generally, by reason of a change produced either in the dimensions, or form, of the atmosphere of the molecule, and that it may thus acquire permanent axes of attractive force. To establish a sufficient basis for a general explanation of crystallization we have only to remark further that the molecule of every particular substance has primarily, and inherently, its own special physical condition, by virtue of which it exercises an effective action that would be represented by a special curve, and experiences under the operation of heat, and other causes, its own peculiar changes of mechanical condition. Upon this idea it may be seen that every substance may have its particular form of crystallization, although the molecules should be devoid of all natural polarity.

The different systems of crystallization may be regarded as so many different systems of equilibrium of masses of molecules, under the operation of molecular forces diversely modified by

the circumstances that determine the crystallization. The general nature of the modifications consists in a spheroidal form imparted to the molecular atmospheres, and the consequent development of certain axes of attraction; that is, of diameters of least or greatest length, in the direction of which the attraction has, at a given distance, a maximum or minimum value, and the limit of stable equilibrium ($O\alpha$, fig. 1) a minimum or maximum value.

Crystallization begins at a certain point of a liquid and is generally determined by the loss of heat, or the evaporation of the liquid solvent. We already have seen reason to believe that the molecules of the liquid have a symmetrical arrangement previous to the crystallization (p. 75). Whether this be admitted or not, such an arrangement obtains in the crystal formed from the liquid. The particles successively take positions in the corners or angular points of a series of polyhedral figures; as cubes, prisms, octahedrons, &c. Any two such figures, lying contiguous to each other, have a common face, or, as in the case of the octahedron, a common angular point. The crystallization takes place, either successively or simultaneously, in the faces of these figures. We have then first to consider the process of crystallization, as it may occur in a single plane.

The result of every such process is the arrangement of the molecules in the angular points of a series of quadrilaterals; which may be squares, rectangles, rhombuses, or rhomboids. If we suppose, in the first instance, several molecules to unite along a single line, and molecules posited on either side of this line to unite with those already crystallized, three different general modes of arrangement may occur; the new particles may take up positions opposite those of the first line, or opposite the middle points of the intervals between these particles, or opposite other than the middle points of these intervals. In the first case, squares or rectangles will be formed; in the second, rhombuses, which may in special cases be squares; and in the third, rhomboids, which in special cases may be rectangles. The general tendency of the crystallization occurring along the first line should be, by reason of the compression of the molecular atmospheres along this line, and the consequent expansion of them in a direction perpendicular to it, to develop an axis of increased attraction in this primary line of crystallization, and an axis of diminished attraction in the perpendicular direction. When this result is reached, and successively along the lines of particles parallel to the first, the figure assumed will be either a square, a rectangle, or a rhombus. The two molecular axes will be coincident with the sides of the minute rectangular figures that make up the larger rectangle, and with the diagonals of each minute rhombus. The condition essential to the forma-

tion of a square is that the properties of the molecules in reference to cooling, (or, in general, in reference to the propagation and absorption of impulses) should be such that each set of four contiguous molecules are, when in the incipient state of crystallization, in the same physical condition. That a rectangle may be formed, a group of four particles must unite, but the escape of the heat-pulses that occurs primarily in the direction of one of the sides of the rectangle must determine a greater compression of the molecular atmospheres in this direction than in that of the other side. That the figure of a rhombus may be assumed, two particles must first unite, and subsequently two other particles must take up, under the attractive action of these, positions opposite the middle of the interval between them. To understand how a rhomboid may result we must observe that when a line of particles is crystallizing, each particle, m, as it becomes united, exerts a certain disturbing action upon a particle m' next in the line, and also upon a contiguous particle, n, at one side of the line. When the particle m' unites it also modifies the condition of n, but as its action is subsequent to that of m, it is possible that in special cases the final result may be an inequality of disturbance, so that m and m' will attract n unequally, and the position of equilibrium assumed by it will in consequence not be opposite the middle of the interval between m and m'. In this case the electric atmosphere of n will have a form differently modified, and its second axis will be oblique to the line of primary crystallization in which the axis first developed lies.

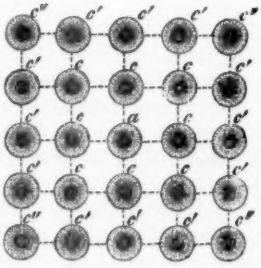
The figure first assumed must then depend upon the fundamental properties, with respect to heat, &c., of the individual molecules of the substance; and the general tendency must be, for the first group of molecules, to acquire increased dimensions by successive solidifications of a series of figures similar to the first.

In what precedes we have had regard only to the play of the ordinary molecular forces, and the modifications which the ordinary molecular action may experience from the loss of heat, and in the act of solidification; but there must result, in each instance of the union of two particles, a modification of the condition of their atmospheres, which should develop a new force of attraction, that may play an important part in the continuation of the process of crystallization. For, when two particles unite by crystallization, their atmospheres, on their nearer sides, will become compressed, and consequently on their farther sides expanded. Each molecule will thus virtually be brought into an electro-polar condition, with the positive pole turned outward. This positive pole, or excess of electric ether, tends to bring all the molecules lying in the prolongation of the line of the first

two into the same electro-polar condition, and, in this state of induced polarization, a force of electric attraction will subsist between the particles. As one particle after another in the line comes to unite with those previously crystallized, its previous polarization will be enhanced, and it will exert an increased attractive force upon those not yet crystallized. At the same time, by the compressive and repulsive action of the contiguous atmospheres, the particle with which the new one unites will lose a considerable portion of its polarity. This reflex action, attendant upon every act of union, should eventually greatly diminish, if not wholly remove, the prior induced polarization.

Another effect of this reflex action, to be noticed, is the increased expansion of the atmosphere of the molecule which experiences the reactive compression, in the direction perpendicular to the line of crystallization. This molecule thus acquires an increased positive polarization on the outer side, lying in this perpendicular direction, and therefore exerts an increased force of electric attraction in this direction. In the varying operation of this induced electric polarization, and of the reflex action just noticed, we may discern the probable origin of those supposed variations of axial attraction, which Professor Dana has shown will suffice for the explanation of secondary planes in crystallization.

2.



To illustrate by a special case, let fig. 2 represent a process of crystallization in which the particles are arranged in successive squares. When c, c, c, are the outer particles, their outer sides will be positively polarized, and will consequently exert an electric attraction, in addition to the increasing molecular attraction that results from the cooling, upon the molecules c', c', c', immediately exterior to them. The next step in the process should be the union of the molecules thus attracted; and all of these molecules should have the same tendency to unite, unless there should be a material inequality in the physical condition of the outer particles c, c, c, c, on different sides of the square c, c, c, c. But the four corner particles, c'', c'', c'', c'', cannot thus be directly brought into union with the particles of the crystal. They must either unite with the nearest particles of those newly attached, or remain disunited, to become incorporated at a later stage of the process. In the normal or complete growth of the crystal, the first would be the result. If, on the other hand, the forces of the new lines of outer particles c', c', c', c', should fall off mate-

LIBRARY OF THE UNIVERSITY OF MICHIGAN

rially in intensity, so that the corner particles, c'', are not taken up in the same step of the process as the others, secondary lines would arise at the angles of the square c', c'', c', c''. In the whole cubical crystal of which fig. 2 represents a section, *secondary planes* would be formed at the edges. Every such line or plane may have different positions, according as the corner particles in question (c'') become incorporated in the next stage of the growth of the crystal, or in some of the subsequent stages. This Professor Dana has distinctly shown. What we have here to observe is simply that by reason of the reflex action above noticed (p. 212), when new particles become united to c', c', these particles, c', c', will in fact exert a more energetic attraction laterally upon c'', c''; and hence the union of c'', c'' with the crystal may then be determined. If not, the next augmentation of the attractive force attendant upon the union of the next set of molecules may determine this result.

In order that a complete polyhedral crystal may be formed, it is necessary that molecules, on one or both sides of a plane in which crystallization occurs, should become united with those that take up their positions at the angles of the plane figure. Thus two sets of four molecules in parallel planes may take up positions of equilibrium at the eight angular points of a cube, or six may form an octahedron, &c. The conditions that will determine the figure of equilibrium assumed, may be inferred from the general considerations already presented (pp. 210 and 211). The compression of the molecular atmospheres in the first plane of crystallization, will tend to develop a third axis of attraction perpendicular to this plane. Various systems of crystallization are possible, since the particles on one side of the first plane may take up positions of equilibrium perpendicularly opposite to those that crystallize in this plane, or opposite the intervals between parallel pairs of these particles, or opposite the centre, of the quadrilateral figure, which they form.[1]

Professor Dana has shown that the various fundamental forms of crystals may be obtained by regarding the crystal as a mass of bi-polar molecules, of a spherical, or spheroidal form, in contact along certain lines, which are the conjugate axes, or conjugate diameters of the spheroids. This conception of the constitution of a crystal is, in a geometrical point of view, equivalent to that which has now been given. For we have only to conceive spheroids to be inscribed in the polyhedral figures of the compound crystal molecules just supposed, to obtain the representative spheroidal molecules of Prof. Dana; which will also touch each other along similar conjugate diameters of the different spheroids. It is not difficult to make out the various positions of equilibrium of the particles that must obtain in the

[1] This is only a partial view of the matter.

different fundamental forms, and the various physical conditions of the particles upon which these forms must depend.[2]

In his paper on Cohesive Attraction, Professor Dana has apparently put the explanation of the *cleavage* of crystals on the true basis, by attributing it to alternations in the intensity of the attraction in a series of parallel planes. If such alternations really exist, we naturally seek for the explanation of them in alternations of the mechanical condition of the molecules upon which the energy of the molecular forces depend. It is conceivable that such differences may result from the heat evolved in the process of crystallization. Let fig. 3, *a*, *b*, *c*, *d*, *e*, &c., be a line of particles crystallizing in regular succession. When *a* unites with *b*, the heat given out will expand the atmosphere of *c*, and it is possible that after this effect has been produced, the expanded atmosphere will not become condensed under the operation of the crystallizing forces, as much as it otherwise would have been; and hence that the molecular attractive force of *c* will be less than would have otherwise resulted. If the attraction between *b* and *c* should thus be materially lessened, there would be in consequence less heat evolved in the union of the two, and so the attractive force of *d* would be less weakened than that of *c* has been. Accordingly, in the union of *c* and *d* an excess of heat would again be given out. In this way, a series of alternations in the intensity of the cohesive attraction might be brought about along the line of crystallized molecules.

3.

It will be observed that the same fundamental idea pervades all the explanations that have now been given of changes of molecular aggregation, whether these are attended with a change of state, or only with a change of density and form. This is the idea that the physical and mechanical condition of a molecule may change with varying circumstances, and that it may undergo a permanent change, although the temperature should remain the same. The change of condition consists simply in the expansion or contraction of the electric atmosphere of the molecule (p. 208). We have recognized, also, that while the processes of transformation are going on, the normal distribution of the electric ether, that forms the atmosphere of a molecule, may become disturbed, and that thus a transient

[2] The hypothesis of a permanent polarity of atoms, or molecules, has subserved a valuable purpose in linking together phenomena under one physical conception, in several departments of Physical Science; but the progress of science has materially tended of late to shake the confidence reposed in it as a supposed truth of Nature. It will be conceded that it is the dictate of true philosophy to hold it in abeyance until it shall have become abundantly evident that the phenomena in question cannot be deduced from the fundamental conception of the constitution of a molecule, and of the primary forces of attraction and repulsion, to which all other molecular phenomena can be referred.

electric polarity of the molecule may be induced, which may play an important part in the process.

Upon the theory of crystallization here offered, the phenomenon of *dimorphism*, and all changes of form, in the same crystal, produced by heat and external causes generally, are but simple results of the modifications superinduced by these causes, in the form, or distance from the central atoms, of the molecular atmospheres; that is, in the physical features of the molecules, upon which the system of crystallization in every instance depends.

Heat.

The general nature of heat, and the general cause of its evolution, have already been considered (p. 64). According to the fundamental ideas presented, heat must be developed whenever the electric atmospheres of the molecules of any substance are urged into closer proximity to the atoms which they surround. Any disturbance of the equilibrium of the particles of a given mass, or any change in the relations of the particles of any body to those of other bodies, which may have the effect to produce this compression of the molecular atmospheres, should then be a source of heat. Thus chemical combination of two particles, in which they are drawn into close union, collision of bodies, external pressure, and friction, are different sources of heat. The disturbance of the electric equilibrium of contiguous molecules may also give rise to the evolution of heat; by reason of the increased repulsion exerted by the excess of electric ether accumulated upon certain of the molecules, or upon one side of them, or of a discharge of the ether occurring from one molecule to another.

Propagation of heat.—Primarily, the heat-pulses are developed in the universal ether associated with the atoms of bodies. These pulses may be conveyed outward through the universal ether, posited between the atoms, and in this way be freely *transmitted* through substances; or they may be more or less taken up, or *absorbed*, by the electric atmospheres of the molecules which they encounter. Such absorbed pulses may be given out again, or *radiated*, in their original form, or they may pass on to contiguous molecules through the *electric* ether that pervades the interval between them. It is probably in this latter mode, chiefly, that heat is *conducted* from particle to particle of a substance, though the pulses that are given out by any particle to the surrounding *universal* ether may be in part propagated onward, absorbed by the particles they encounter, and partially propagated onward again in the same manner to the next particles.

The flow of heat from one particle to another of a substance tends to disturb the electric condition of the particles; for the

repulsive action of the heat-pulses in the atmosphere of one particle tends to urge away a portion of the electric ether from the contiguous side of the next particle in the line of propagation, and so to induce a negative electric state upon that side, and a positive state on the farther side. This disturbance of the electric equilibrium of contiguous molecules may give rise to a discharge of the electric ether from the one to the other, and a consequent more ready propagation of the heat pulses from the one to the other. Upon this idea there is a close analogy between the conduction of heat and the conduction of electricity in the galvanic current; both depending upon the facility with which an electric polarization of contiguous particles is determined. The origin of this propagated polarization, in the one case, is the addition of repulsive pulses to the atmosphere of a molecule, and, in the other, the accumulation of an excess of the repulsive electric ether around a molecule, or upon one side of it. A confirmation of these views is afforded by certain phenomena of thermo-electric currents, from which it appears that the conduction of heat is in reality attended with the disturbance of the electric equilibrium;[3] and they are also sustained by the fact of the close agreement that subsists between the conducting powers of the metals for heat and electricity. The analogy between the conduction of heat and the conduction of a galvanic current may be more fully stated, thus: A stream of heat consists of two sets of pulses, viz: those conveyed by the electric ether, and those conveyed by the universal ether; and the propagation is attended with, and partly by means of, an induced molecular polarization. The pulses propagated by the electric ether tend to develop this polarization, which determines a discharge of ether from one atmosphere to the next. But the other set of pulses, in proportion as they are taken up by the nearer side of the next atmosphere, tend to weaken the induced polarization, and so to check the flow of the heat. A galvanic current comprises two similar sets of pulses, is attended and promoted still more effectually by a similar molecular polarization, and the absorption of the ethereal pulses, and their subsequent emission as heat tends to check the flow of the current.

The feeble conducting power of many substances is probably due to an aggregation of their particles in groups, with large intervening spaces. The bad conductibility of gases and liquids, both for heat and galvanic electricity, agreeably to the views just offered, must be ascribed to a feeble polarizing action of one particle upon another. This appears to be a consequence of the peculiar state of the molecular atmospheres which determines the fluid condition (p. 75), combined with the effective mutual repulsion of the particles in this condition. In the case

[3] See De la Rive's Treatise on Electricity, vol. ii, p. 536, &c.

of liquids, like water, whose ultimate molecules are compound, a portion of the heat propagated should be consumed in expanding the compound molecules.

Capacity of Bodies for Heat.—The fundamental law discovered by Dulong and Petit, that the specific heats of elementary substances are inversely proportional to their chemical equivalents, or atomic weights,—or, in other words, that the atoms of such substances have the same capacity for heat,—if interpreted in the language of the present theory, amounts to this, viz: whatever may be the difference of condition of the molecular atmospheres of elementary substances, if the same amount of heat be imparted to these atmospheres, the same amount will be given off again and interchanged with surrounding bodies having the same temperature. This would seem to imply that the portion of the heat absorbed, which is consumed in expanding the atmosphere, is the same for different simple molecules, and that the remaining portion, which is taken up as new pulses by the atmosphere, is also the same for molecules of different elementary substances. There is nothing in the conception we have formed of a molecule, and of the probable difference of physical condition in molecules of different substances, that is apparently opposed to this result.

The capacity for heat of compound is in general greater than that of simple molecules, and is greater in proportion as the molecule is more complex. This indicates that when the temperature is raised 1°, a certain portion of the heat is expended in urging asunder the constituents of the molecules, and that this portion is greater in proportion as the molecule is more complex.

Heat-rays of different rates of vibration.—The calorific spectrum shows that the heat emitted from a hot body is composed of rays of an infinite variety of rates of vibration, between certain limits. The physical cause of this fact will appear if we reflect that the heat-rays have their origin in the vibrations of the atomettes of the molecular atmospheres, and that these are situated at every variety of distance from the central atoms, between certain limits. For the circumstances of equilibrium of these atomettes are different, and their rates of vibration when displaced should be different. The fact that the most intense heat-rays, in ordinary cases of combustion, are those of low refrangibility, and the phenomena of the evolution of calorific and luminous rays when a body is heated to incandescence, indicate that the electric atomettes which are nearest the central atoms have the lowest rate of vibration.

We have seen that the expansive action of heat is a necessary consequence of the fundamental principle that the heat-pulses constitute a repulsive force, and that they are absorbed, more or

less, by the molecular atmospheres which they encounter. It may be urged as an objection to the notion that radiant heat is a repulsive force, that bodies when heated do not exert any sensible repulsive action upon other contiguous bodies. We are not prepared to admit that experiment has furnished no evidence of such repulsive action, under any circumstances, but the entire absence of such action upon bodies of sensible magnitude would in fact be no decisive proof that waves of radiant heat do not convey a series of preponderating repulsive impulses; for if these impulses penetrate to the atoms of the molecules, they should be ultimately taken up by their atmospheres, and expended as an expansive force upon these atmospheres, and in urging the molecules asunder; and if they do not reach the atoms, no motion should be imparted to them. Since it is improbable that the more intense impulses of heat will be wholly absorbed by the particles immediately at the surface of the body upon which they fall, a direct repulsive action of the heat may take effect to a certain depth below the surface. Have we not in the spheroidal state of liquids evidence of such action exerted by the radiant heat from the hot vessel upon the liquid resting upon its interior surface?

It is only when the heat-waves impinge upon isolated particles, or a small group of particles, that a progressive motion should be imparted. This supposition is apparently realized in the case of cometary matter repelled by the sun.[4]

Light.

The question of the precise relation which the two physical agents, light and heat, bear to each other, has not been definitively settled; but the weight of evidence preponderates very decidedly in favor of the doctrine of their essential identity. The only "formidable outstanding objection" to this view consists in the fact that a strong light may be obtained which has little, if any, heating power.[5] According to Melloni, the greenish light, obtained by transmission of white light through a peculiar species of green glass colored by oxyd of copper, "exhibits no calorific action capable of being rendered perceptible by the most delicate thermoscopes, even when it is so concentrated by lenses as to rival the direct rays of the sun in brilliancy."

[4] In the article by the author, "On the Theoretical Determination of the Dimensions of Donati's Comet," (see this Journal, vol. xxxii, No. 94, p. 54, &c.) it is established, by rigorous calculation, that the particles of matter disseminated over the breadth of the tail of the comet, were exposed to a force of repulsion from the sun, of various degrees of intensity, between two ascertained limits. In the light of the theoretical views now offered, we must conclude that the matter thus unequally repelled consisted of particles of different sizes, or different absorptive powers for heat, or of different sized groups of particles.

[5] (See Report of Rev. Baden Powell, M.A., F.R.S., for 1854, on Radiant Heat, published in the Smithsonian Report for 1859, p. 368.)

May it not be that the explanation of the possible existence of light without heat, thus made out, is to be found in the presence, in the luminous beam, of a certain number of radiations which have individually too feeble an intensity to exercise any calorific action upon bodies, but are still capable of producing a sensible impression upon the organ of vision? Upon the theory of the constitution of molecules adopted in the present paper, we may suppose that vision results from some action of the luminous pulses upon the molecular atmospheres merely, while heat-expansion is not produced unless the individual pulses have sufficient intensity to penetrate to the surface of the central atoms of the molecules. According to this idea, as rays that penetrate to different depths in the molecular atmospheres of a medium should be unequally absorbed, the rays of feeble intensity, or of pure light, may be separated from those which by reason of their greater intensity are capable of penetrating to the atoms of the medium, and exercising a calorific action upon them.

It is generally admitted that vision is produced by the transverse vibrations of the rays of light. The fact that when two rays of heat, polarized in perpendicular planes, meet in opposite states of vibration, they do not neutralize each other, has been generally regarded as an indication that the calorific action of a ray must also result from transverse vibrations; but this does not appear to be a legitimate conclusion if we adopt Professor Challis's theory, that the luminiferous ether is a highly elastic fluid, having the same properties as elastic fluids in general, and that the ethereal undulations consist of simultaneous longitudinal and transverse vibrations, attended with variations in the density of the medium, as in the case of waves of sound. For if transverse vibrations, in perpendicular planes, meet in opposite states, they cannot neutralize each other, and must develop direct vibrations, which will take the place of those which counteract each other, and will exert a calorific action. In fact, Prof. Challis conceives that "heat is the result of the mechanical action of the direct vibrations;" while "light is due to the transverse vibrations."

The intimate association of heat and light leads to the inference that they emanate from the same source, viz: the molecular atmospheres of bodies; and if, as has been intimated, the two emanations are essentially the same, we infer that rays of light, as well as of heat, originate in vibratory movements of the atomettes of these atmospheres. The atomettes lying at different distances from the central atom of a molecule will have different rates of vibration, increasing with the distance, and so the waves proceeding from them will have every variety of pulsation between the lowest limit, answering to the bottom, and the highest, answering to the top of a molecular atmos-

phere. Accordingly the red rays will proceed from the lower portions of the atmosphere, and the violet from more elevated portions.

If the electric atmospheres diminish in density by insensible degrees from bottom to top, there should be no break in the continuity of the rays between the two extremes. But we know, from the existence of bright bands in the spectra obtained from colored flames, and from the highly heated vapors of metals and other substances, that the rates of vibration of the luminous rays given off by incandescent vapors, seldom, if ever, vary by insensible degrees from one extreme to the other. We must conclude therefore that the electric atmospheres of highly heated molecules are made up of distinct layers of unequal density.

Phenomena, attending the propagation of light. The *absorption* of light by a medium may be regarded as the taking up of the ethereal pulses by the electric atmospheres of the medium. In order that a ray may be completely absorbed it must encounter a layer of the electric atmosphere of a molecule, which pulsates naturally in unison with the wave-pulsation of the ray. The absorbing action of a molecule should therefore depend upon the physical condition of its atmosphere as to rates of pulsation, density, &c., and also upon the comparative extent of its electric and ethereal atmospheres. For example, a medium would permit the free passage of any ray that did not penetrate to the surface of the electric atmospheres of its molecules. On the other hand, a medium would intercept rays that should penetrate to atmospheric layers that are in unison with the rays. Accordingly, if an incandescent vapor should emit rays of certain colors, as shown by bright bands in its spectrum, those colors, if transmitted through the vapors, should be absorbed, and the spectrum given by transmitted light should show dark lines answering to the bright lines of the other spectrum—which is the well known discovery of Kirchhoff and Bunsen.

According to the theory of crystallization presented on p. 209, &c., in all the systems of crystallization in which the axes of molecular attraction are unequal, the electric atmospheres of the molecules are compressed unequally in the lines of direction of these axes. Now if these atmospheres are compressed unequally, the same will be true of the ethereal atmospheres which pervade them. Thus in all forms of crystals which have unequal axes, the ethereal atmospheres of its separate particles will have unequal densities in the directions of the molecular axes. It is well known that all such crystals have the property of double refraction, and that this property is attributed to a supposed inequality of density, or of elasticity, of the ether in the direction of certain molecular axes. A mechanical pressure exerted along a certain line, or plane, also develops the property of double-

refraction, in ordinary refracting media; and such compression should give rise to an increased density of the ethereal atmospheres along the line of pressure. Accordingly our general theory of the constitution of molecules, and of molecular forces, conducts to the physical basis assumed in the undulatory theory of light, in explanation of double-refraction.

The phenomenon of "atomic circular polarization" by liquids, discovered by Biot, who established that the effect depended solely upon the number of atoms encountered by the light, whatever may be the density of the medium, and the phenomenon of "magnetic circular polarization," in which the direction of rotation of the plane of polarization corresponds with that of the revolution of the circular magnetic currents, are decided indications that optical phenomena result mainly from the action of the *atmospheres* of molecules upon the rays of light. Numerous facts, which go to show that the absorptive action of media upon light and heat depends in a great degree upon the physical constitution of the separate molecules, confirm this conclusion.

The general phenomena, and laws, of reflexion, refraction, polarization, diffraction, &c., should obtain upon this supposition no less than upon the conception that the phenomena are to be referred to the interstitial ether. It remains to be seen whether the theorems and formulæ deduced by Fresnel, and other physicists, from the undulatory theory of light, can be shown to be substantially in accordance with this notion of molecular actions.

Note.—Objections to the theoretical views offered on the preceding pages, will readily occur to the scientific reader, but it does not comport with the design of the present communication to anticipate objections, or to attempt to enforce the general conclusions deduced from the fundamental positions taken, by appeals to special facts. We must be content, for the present, to rest our conclusions mainly upon general considerations. A connected view of the whole ground to be surveyed is almost a necessary preliminary to the many detailed investigations that must be undertaken before the theory can be established on a firm foundation.

It will be perceived that the most characteristic feature of the general theory under discussion is that it locates the source of physical phenomena in the atmospheres of molecules, instead of in the atoms, or in the interstitial ether. In pursuing our deductions into other departments of Physics, other general conceptions have been reached, some of which it may be advisable to state here; as circumstances may delay somewhat the publication of the remainder of the article.

1. An *electric current* (hydro-electric, or thermo-electric) has its origin in the opposite polarization of the adjacent sides of contiguous molecules, developed by the play of the molecular

forces, under special circumstances, or by an inequality in the action of the pulses of heat upon the atmospheres of the molecules. The current consists of an actual flow of electric ether from molecule to molecule, determined by a previous electric polarization propagated from that which is the source of the current. There are also conveyed in the direction of the positive current, streams of impulses, both by the electric, and universal ether, which, by a partial lateral dispersion, produce the magnetic effects of the current.

2. The *mutual attractions*, or *repulsions*, exerted between two electric currents may be ascribed to a change in the tension of the ether between the wires, produced by the lateral actions of the currents.

3. *Induction currents* result from an electric polarization of the molecules, suddenly induced by the same lateral action of a primary current when first established, or by the increased action of a previous electric, or magnetic current; or suddenly vanishing, when the circuit is broken, or the force of action decreases. The polarization, in the first instance, is the opposite to that which prevails in the primary current; owing to the indirect nature of the inducing action.

4. The *circular currents of a magnet*, consist of electric currents that follow continuous chains of particles lying in the surface of the compound molecules of the magnet. These currents have their origin in an electric polarization of the particles, developed by a direct action of the impulses propagated from the exciting current. In permanent magnets the polarization thus originated becomes permanently established, and a permanent current remains, *as a necessary consequence of the play of the molecular forces in the chain.* A magnet, therefore, derives its power directly from the inexhaustible primary forces of attraction and repulsion, and must retain its virtue unimpaired until the chain of molecules is broken by heat, or the excited molecular conditions upon which the currents depend are removed by some external cause.

5. *Terrestrial magnetism* is due to electric currents in the mass of the earth, running in the general direction from east to west, and developed by the collision of the molecules with the ether of space. Both the rotatory and orbital motion of the earth are concerned in producing these currents. A part of the force of such currents must be converted into heat, and the earth derive a portion of its heat from this source. If this be true the remarkable formal relations that subsist between the magnetism and heat of the earth, are probably the result, in a great degree, of this physical bond by which the two principles are partially united. (See the investigation, by the author, of these relations in an article on Terrestrial Magnetism, published in vol. iv, second series of this Journal).

This theory of the origin of terrestrial magnetism, as a part of the general theory of Molecular Physics, here presented, was brought, by the author, to the notice of the Connecticut Academy, about two years since. It appears, from a pamphlet recently received by the editors of this Journal, that a theory quite similar to this was propounded several years since by Gustav Hinrichs, of Copenhagen. The theory of Hinrichs, or one having the same essential features, I find is advocated by Prof. Challis, in the Number of the Philosophical Magazine published in February, 1861.

[To be continued.]

ART. XXIII.—*Notice of the Remains of a Mastodon recently discovered in Michigan;* by Professor ALEXANDER WINCHELL.

SOME remains of a Mastodon have recently been exhumed in Michigan, which possess sufficient interest to deserve a scientific notice. They were found on Sec. 7, in the township of Adrian, Lenawee county, about seven miles northwest of the city of Adrian. The bones thus far discovered consist of the cranium, with the exception of the nasal bones; five molars, four of which lack their roots; the terminal portions of the two tusks, each about 18 inches long, and another fragment of a tusk a foot in length; two caudal vertebræ; two scapulæ; two femora; two tibiæ; one fibula; two calcanea; two humeri; one radius; sundry carpal, tarsal, metacarpal and metatarsal bones; three or four digital bones; three perfect ribs, and numerous fragments. The whole series of vertebræ (except two caudal) has disappeared, as well as the pelvis, the lower jaw, the nasal bones, about half of the bulk of the anterior extremities, and many of the ribs. The epiphyses of the long bones are nearly all detached, but most of them have been recovered. The state of ossification indicated by the separation of the epiphyses, the unworn teeth, and the inferior size of the bones, all tend to demonstrate that we have here the remains of a Mastodon not more than two-thirds grown.

These relics were found buried about two feet only beneath the surface of a small peat bog which was being ditched. Beneath the peat, which is not more than two and a half feet thick, we have marly clay, passing, at the depth of four feet, into loose sand. The skeleton was lying on the side. One fore-leg was extended; the other bent under the body. The hinder parts were a little the deepest in the mire. It is stated that many years ago this spot was known as a "deer lick."

It is generally supposed that the occurrence of elephantine remains in miry bogs indicates the mode of death of these ponderous quadrupeds. It may be doubted, however, whether their occurrence exclusively in peat, or beneath it, is not attributable to the antiseptic properties of that substance.

The bog in which the present remains were found, is perfectly identical with thousands of others in our State, which are known, from observation, to be in process of formation in the sites of ancient lakelets, and at a rate which argues a comparatively short duration for the alluvial period of the State. Indeed, the watery and shaking condition of this bog, with the thinness of the peaty stratum, furnish data for the belief that it was the bed of a lakelet within a comparatively short period. It is much more credible that the Mastodon under consideration was living within 500 or 1000 years, than that an interval of time, greater than the age of the human race, has been occupied in the accumulation of two or three feet of vegetable deposits, under circumstances which suffer the same work to be accomplished, in neighboring localities, within the space of a human life-time. It is more than probable that the American Indian, according to his own traditions, and according to the evidences adduced by Dr. Koch, has listened to the thunder-waking tread of these monsters of the forest and the field.

Other mastodon remains have been found at various points within the lower peninsula of Michigan, some of which are Petersburg, Monroe county; the city of Adrian, Lenawee county; Utica, Macomb county; Green Oak, Livingston county; Fentonville, Oakland county; and Terre Coupée, Berrien county. (See Proc. Bos. Soc. Nat. Hist., v, 133, 146, 158.) The localities of several other discoveries have been lost. The molar teeth of *Elephas Jacksoni* are also of occasional occurrence, in the same situations; as well as the antlers of the deer and American elk. Some years ago, the caudal vertebra of a Cetacean was identified by Dr. Sager from the western portion of the State.

The remains of the Mastodon noticed above will probably be secured for the Museum of the University, when an occasion may be furnished for a fuller account of the fossil mammals of Michigan.

University of Michigan, June 16, 1864.

ART. XXIV.—*Chladnite of the Bishopville Meteoric Stone proved to be a Magnesian Pyroxene;* by J. LAWRENCE SMITH, Prof. Chem. Med. Dep. University of Louisville.

IN 1846, Prof. C. U. Shepard published an account of an exceedingly interesting meteoric stone that fell at Bishopville, South Carolina, in 1843, differing in its external character from other meteoric stones; the fractured mass being exceedingly white, except where metallic iron and other associate minerals occur. I would refer the reader to Prof. Shepard's description of it in this Journal, Sept. 1846, p. 381.

The composition of the snow-white mineral (constituting about 90 pr. ct. of the entire mass) as given by Prof. Shepard is—

		Oxygen.	Ratio of ox.
Silica,	70·41	35·205	3
Magnesia,	28·25	11·300	1
Soda,	1·39	·338	

From the results of this analysis he considered it a *tersilicate of magnesia*, constituting a new species to which he gave the name *chladnite*.

Several years after this examination, a fragment of this meteoric stone came into my possession, and separating a small portion of the mineral in question it was examined. The result of this incomplete examination justified the statement in a note to a memoir of mine on meteorites, presented to the Amer. Scientific Association in April, 1854, and published in this Journal for March, 1855, p. 162, "that from some investigations just made, chladnite is likely to prove a pyroxene."

Since that announcement I have been placed in possession of other fragments of the meteorite, and have been able to separate the "chladnite" perfectly pure, and in sufficient quantity to submit it to a thorough analysis.

To render the chladnite soluble in acid, it was fused with four times its weight of carbonate of soda and potash, with a small fragment of caustic potash placed on the top of the mixed powders in the crucible.[1] After fusion, the analysis was proceeded with in the ordinary way; the results of two analyses were as follows:

	1.	2.
Silica,	60·12	59·83
Magnesia,	39·45	39·22
Peroxyd of iron,	·30	·50
Soda, with feeble potash and strong lithia reaction,	·74	·74
	100·61	100·29

[1] I would remark that I seldom or ever fuse a silicate with the alkaline carbonates, without the addition of a small piece of caustic potash or soda, and never analyze a known or supposed pyroxene or hornblende without this precaution. I have no doubt that there are many minerals classified with hornblende, which properly belong to pyroxene, the silica in the analyses being rated too high, an error arising from an imperfect fusion.

The minute quantity of peroxyd of iron came from exceedingly fine particles of iron diffused through the minerals, and could be seen by a magnifying glass. One separate analysis was made for the soda.

The constitution of the mineral, as made out from the numbers in analysis 1, is—

	Oxygen.	Oxygen ratio.
Silica,	31·22	2
Magnesia,	15·51	1
Soda,	·19	

corresponding to the formula $\dot{M}g^3\ddot{S}i^2$, equivalent to the general formula of pyroxene, $\dot{R}^3\ddot{S}i^2$.

The excess of silica obtained by Prof. Shepard in his analysis is doubtless due to an imperfect fusion of the mineral with the carbonate of soda, an error easily made, if the precautions I have already mentioned are not attended to.

"Chladnite" approaches those forms of pyroxene known as white augite, diopside, white coccolite, &c.; these last named minerals having a part of the magnesia replaced by lime. It is identical in composition with *Enstatite* of Kenngott, a pyroxenic mineral from Aloysthal in Moravia (this Journal, [2], xxi, 200).

From these observations it will be seen that the Bishopville meteoric stone, however different in external characteristics from other similar bodies, is, after all, identical with the great family of pyroxenic meteoric stones.

Art. XXV.—*Aerial Tides;* by Pliny Earle Chase, M.A., S. P.A.S.[1]

The remarkable coincidence, which I have pointed out, between the theoretical effects of rotation and the results of barometrical observations, has led me to extend my researches with a view of defining more precisely some of the most important effects of lunar action on the atmosphere. The popular belief in the influence of the moon on the weather, which antedates all historical records, has received at various times a certain degree of philosophical sanction. Herschel and others have attempted partially to formulate that influence by empirical laws; but the actual character of the lunar wave that is daily rolled over our heads appears never to have been investigated. Major-General Sabine showed that the moon produces a diurnal variation of the barometer, amounting to about ·006 of an inch, which is

[1] From the Proceedings of the American Philosophical Society.

equivalent to nearly one-tenth of the average daily variation near the equator. This would indicate a tidal wave of rather more than one foot for each mile's depth of atmosphere, or from three to six feet near the summits of the principal mountain chains. It is easy to believe that the rolling of such a wave over the broken surface of the earth may exert a very important influence on the atmospheric and magnetic currents, the deposition of moisture, and other meteorological phenomena. As the height of the wave varies with the changing phases of the moon,[1] its effects must likewise vary, in accordance with mathematical laws, the proper study of which must evidently form an important branch of meteorological science.[2]

Besides this daily wave, there appears to be a much larger, but hitherto undetected, weekly wave. Mr. Flaugergues,[3] an astronomer at Viviers in France, extended his researches through a whole lunar cycle, from Oct. 19, 1808, to Oct. 18, 1827, and he inferred, from his observations:

1. That, in a synodical revolution of the moon, the barometer rises regularly from the second octant, when it is the lowest, to the second quadrature, when it is the highest, and then descends to the second octant.

2. That the varying declination of the moon modifies her influence, the barometer being higher in the northern lunistice than in the southern.

3. That the action of the moon also varies with its distance from the earth, the mean barometric height being less in perigee than in apogee.

The observations indicate the following average meridional fluctuations of the barometer:

1. In a semi-synodical revolution, 1·67 mm., or ·065 in.
2. Between the lunistices, ·29 mm., or ·011 in.
3. Between perigee and apogee, 1·12 mm., or ·044 in.

The more recent and more complete observations at St. Helena give somewhat different results, which serve to confirm the natural *à priori* conviction that there must be two maxima and minima in each month. The means of three years' hourly observations indicate the existence of waves, which produce in the first quarter a barometric effect of +·004 in.; in the second quarter of −·016 in.; in the third quarter of +·018 in.; and in the fourth quarter of −·006 in.; results which appear to be *precisely* accordant, in their general features, with those which would be naturally anticipated from the combination of the cu-

[1] The height at St. Helena appears to fluctuate between about ·9 and 1·6 feet.

[2] For some interesting experimental evidences of the effect of the moon's changes on the fall of rain, see the published observations of Messrs. F. Marcet (this Journal, xxvii. 192); and J. H. Alexander (this Journal, [2], xii, 1).

[3] Bib. Univ., Dec. 1827, and this Journal, xv, 174.

mulative effect of the moon's attraction with the daily wave of rotation, and the resistance of the æther.

One peculiarity of this lunar-aerial wave deserves notice for the indirect confirmation that it lends to the rotation theory of the daily aerobaric tides, and the evidence it furnishes of opposite tidal effects, which require consideration in all investigations of this character. When the daily lunar tides are highest their pressure is greatest, the lunar influence accumulating the air directly under the meridian, so as to more than compensate for the diminished weight consequent upon its "lift." But in the general aerial fluctuations, as we have seen, and also in the weekly tides, a high wave is shown by a low barometer, and *vice versâ*. The daily blending of heavy and light waves produces oscillations, which are indicated by the alternate rise and fall of the barometer and thermometer at intervals of two or three days.

Mr. Flaugergues's observations at perigee and apogee seem to show that a portion of the movement of the air by the moon is a true lift, which, like the lift of rotation, must probably exert an influence on the thermometer as well as on the barometer. On comparing the daily averages at each of the quadratures and syzygies, I found the difference of temperature too slight to warrant any satisfactory inference; but a similar comparison of the hourly averages, at hours when the sun is below the horizon, gave such results as I anticipated, as will be seen by a reference to the following

Table of barometric and thermometric means at the moon's changes.

Moon's phase.	Average height of barometer in inches.	Height of weekly tides.	Height of daily tides.	Height of thermom. daily average.	Thermom. at 12 P. M.	Thermom. at 4 A. M.
Full,.....	28·270	−·0115 in.	·0054 in.	61·67°	60·22°	59·787°
Third qr.,...	28·289	+·0065 "	·0087 "	61·68	60·41	59·824
New,.....	28·282	+·0005 "	·0064 "	61·65	60·31	59·716
First qr., ...	28·286	+·0044 "	·0047 "	61·63	60·37	59·823

In obtaining the above averages I was obliged to interpolate for such changes as took place on Sundays or holidays, when no observations were taken. The interpolation, however, does not affect the general result; and, on some accounts, the table is more satisfactory than if the observations had been made with special reference to a determination of the lunar influences, accompanied as such a reference would very likely have been, by a bias to some particular theory.

The thermometric and barometric averages show a general correspondence in the times of the monthly maxima and minima,—the correspondence being most marked and uniform at midnight, when the air is most removed from the direct heat of

the sun, and we might therefore reasonably expect to find the clearest evidences of the relation of temperature to lunar attraction.

By taking the difference between the successive weekly tides, we readily obtain the amount of barometric effect in each quarter. The average effect is more than three times as great in the second and third quarters, as in the remaining half month,—a fact which suggests interesting inquiries as to the amount of influence attributable to varying centrifugal force, solar conjunction, or opposition, temperature, &c.

Although, as in the ocean tides, there are two simultaneous corresponding waves on opposite sides of the earth, these waves are not of equal magnitude, the barometer being uniformly higher when the moon is on the inferior meridian, and its attraction is therefore exerted in the same direction as the earth's, than when it is on the superior meridian, and the two attractions are opposed to each other.

I find, therefore, marked evidences of the same lunar action on the atmosphere as on the ocean,—the combination of its attraction with that of the sun producing, both in the air and water, spring tides at the syzygies, and neap tides at the quadratures; and I believe that the most important normal atmospheric changes may be explained by the following theory:

The attraction and rotation-waves, as will be readily seen, have generally opposite values, the luni-solar wave being

Descending, from 0° to 90° [4], and from 180° to 270°.
Ascending, from 90° to 180°, and 270° to 360°.

While a rotation wave is

Ascending, from 330° to 60°, and 150° to 240°.
Descending, from 60° to 150°, and 240° to 330°.

From 60° to 90°, and 240° to 270°, both waves are descending while from 150° to 180°, and 330° to 360°, both are ascending. In consequence of this change of values, besides the principal lunar maxima and minima at the syzygies and quadratures, there should be secondary maxima and minima at 60° in advance of those points.

The confirmation of these theoretical inferences by the St. Helena observations appears to me to be quite as remarkable as that of my primary hypothesis. If we arrange those observations in accordance with the moon's position, and take the average daily height of the barometer, we obtain the following

[4] Counting from either syzygy.

Table of the lunar barometric tides.

Moon's position. θ*	Mean daily height of barometer at St. Helena. 28 inches + the numbers in the Table.			
	1844.	1845.	1846.	Average. 1844-6.
0°	·2621	·3020	·2701	·2781
15	·2650	·3058	·2693	·2800
30	·2707	·3153	·2707	·2856
45	·2691	·3165	·2688	·2848
60	·2625	·3077	·2688	·2797
75	·2682	·3093	·2783	·2853
90	·2667	·3184	·2800	·2884
105	·2593	·3170	·2721	·2828
120	·2595	·3124	·2686	·2802
135	·2677	·3099	·2691	·2822
150	·2712	·3118	·2715	·2848
165	·2710	·3104	·2735	·2850
180	·2621 †	·3020	·2701	·2781

This table shows—

1. That the average of the three years corresponds *precisely* with the theory, except in the secondary maximum, which was one day late.

2. That the primary maximum occured at the quadratures in 1845 and 1846, and one day before the quadratures in 1844.

3. That the primary minimum occurred at the syzygies in 1844 and 1845, and one day after the syzygies in 1846.

4. That 1846 was a disturbed year; and, if it were omitted from the table, each of the remaining years, as well as the average, would exhibit an entire correspondence with theory, except in the primary maximum of 1844.

5. That 1845 was a normal year, the primary and secondary maxima and minima all corresponding with theory both in position and relative value.

6. That the deviations from perfect correspondence with theory can be easily explained by the relative positions of the two aerial ellipsoids of rotation and attraction.

7. That the tertiary maxima and minima, or the turning-points between the primary and secondary maxima and minima, are less stable than the primaries and secondaries.

At extra-tropical stations I should look for important modifications of the theoretical results, some of which I propose to explain hereafter.

In a former communication on the rotation-tide, I stated that "the law of tidal variation, derived from an exclusive reference of the aerial motions to a supposed stationary earth, is precisely

* Counting from either syzygy.

† Since the tabular numbers represent the *semi-axes* of the barometric curve, and not the simple *ordinates*, the values for 0° and 180° are the same.

the same as the law that is derived from the consideration of the relative attraction of the two bodies revolving about their common centre of gravity." That such would be the case might have been reasonably expected from the dependent connection of rotation and revolution with gravity.

I was therefore led to believe that the daily lunar tides might be indicated by the same expression as the weekly lunar and daily rotation tides. On investigation, I find that such is indeed the case. If M is the barometric mean for any given day and place, and θ is the moon's altitude, the lunar tide may be expressed by $MC(\sin\theta\cos\theta)$, C being a constant to be determined for each station.

The rationale of Mr. Flaugergues's second and third inferences thus becomes evident; the phenomena of ocean tides are connected with those of the air, which, being subject to fewer extraneous disturbing influences, can therefore be more easily investigated; and the long-suspected obedience of the principal meteorological changes to fixed mathematical laws is at length demonstrated.

ART. XXVI.—*Extracts from the Address of Dr. J. W. Dawson, President of the Natural History Society of Montreal, at its annual meeting, May* 18, 1864.[1]

Fossils of the Laurentian.

BY far the most important publication of the past year, in the Natural History of Canada, has been the great Report of the Geological Survey, a work in which, as the achievement of members of this Society, we may very well take pride; and on which we may congratulate ourselves as facilitating the labors of those among us who pay attention to geology, either with a view to practical or scientific results, and as greatly raising the scientific reputation of this country. The Report of the Survey has already been reviewed in the *Naturalist*, and I propose here, not so much to say anything as to its general merits, as to refer to a few points in Canadian geology to which it directs our attention.

One of these is the discovery of fossils in the old Laurentian rocks, heretofore usually named *Azoic*, as being destitute of life, and much older than any rocks known to contain fossils. The oldest remains of living beings, until this discovery, had been found in rocks known as Cambrian, or Primordial, and equivalent in age to our oldest Silurian of Canada, or at the most to our Huronian. But the Huronian series in Canada rests on the

[1] From the Canadian Naturalist, 1864.

upturned edges of the Laurentian, which had been hardened and altered before the Huronian series was deposited. Again, Sir William Logan has shown that the Laurentian system itself contains two distinct series of beds, the upper of which rests unconformably on the lower. There are thus in Canada at least two great series of rocks, of such thickness as to indicate two distinct periods, each of vast length, below the lowest fossiliferous rocks of other countries. Yet, in the lowest of these so-called Azoic groups, fossils have now been found; Canada thus far distancing all other parts of the world, so far as yet known, in the antiquity of its oldest fossils.

I have had the happiness to submit these remarkable specimens to microscopic examination, at the request of Sir W. E. Logan, and have arrived at the conclusion that they are of animal nature, and belong to the very humblest type of animal existence known, that of the *Rhizopods*, though they far outstrip in magnitude any known modern representation of that group. The discovery of this remarkable fossil, to be known as the *Eozoön Canadense*, will be one of the brightest gems in the scientific crown of the Geological Survey of Canada.

In connection with this subject, it is to be observed that the grand order of succession in the older number of the Laurentian system of rocks seems to be the same with that so often represented in other parts of the geological scale. First, a coarse fragmentary series, represented by conglomerate and gneiss; next, a calcareous and fossiliferous band, represented by the Eozoön limestones; next, a finer earthy series, represented by dioritic rocks. This brings the Laurentian into a cycle somewhat similar to that of the Potsdam sandstone, the Chazy and Trenton limestone, and the Utica slate and Hudson river in the Lower Silurian; or to that of the Medina sandstone, the Niagara limestone, and Lower Helderberg in the Upper Silurian; or to that of the Oriskany sandstone, Corniferous limestone, and Hamilton and Chemung groups in the Devonian; or to that of the Lower Carboniferous conglomerates and sandstones, the Carboniferous limestones, and the Coal measures in the Carboniferous period. This recurrence of cycles of deposit cannot be accidental. It is more or less to be seen throughout the geological scale, and in all countries; and, as I have elsewhere pointed out, it includes numerous subordinate cycles within the same formation, as in the coal measures. Eaton, Hunt, and Dana have called attention to it; but it deserves a more careful study as a means of settling the sequence of oscillations of land and water in connection with the succession of life. It will also be important in giving fixity to our geological classifications, and may eventually aid in establishing more precise views of the dynamics of geology and of the lapse of geological time. The progress of the

earth has, like most other kinds of progress, been not by a continuous evolution, but by a series of cycles, of great summers and winters, or days and nights of physical and vital change, in each of which all things seem to revolve back to the place of beginning, only to begin a new cycle, or new turn of a spiral, similar to the last in its general course, though altogether different in its details, accompaniments and results.

On the Boulder Drift of Canada.

There is another subject of great geological importance, on which the publication of the report enables strong ground to be taken. I refer to the conditions under which the *Boulder Drift* of Canada was deposited. It has been customary to refer this to the action of ice-laden seas and currents, on a continent first subsiding and then re-elevated. But this opinion has recently been giving way before a re-assertion of the doctrine that land glaciers have been the principal agents in the distribution of the boulder drift, and in the erosions with which it was accompanied. I confess that I have steadily rejected this last doctrine, being convinced that insuperable physical and meteorological objections might be urged against it, and that it was not in accordance with the facts which I had myself observed in Nova Scotia and in Canada. The additional facts contained in the present report enable me to assert with confidence, though with all humility, that glaciers could scarcely have been the agents in the striation of Canadian rocks, the transport of Canadian boulders, or the excavation of Canadian lake basins. In making this statement I know that I differ in some degree from many of my geological friends, but I know that they will be rejoiced that I should freely and frankly state the reasons of my belief.

The facts to be accounted for are the striation and polishing of rock surfaces, the deposit of a sheet of unstratified clay and stones, the transport of boulders from distant sites lying to the northward, and the deposit on the boulder clay of beds of stratified clay and sand, containing marine shells. The rival theories in discussion are: *first*, that which supposes a gradual subsidence and re-elevation, with the action of the sea and its currents, bearing ice at certain seasons of the year; and, *secondly*, that which supposes the American land to have been covered with a sheet of glacier several thousands of feet thick.

The last of these theories, without attempting to undervalue its application to such regions as those of the Alps, or of Spitzbergen or Greenland, has appeared to me inapplicable to the drift deposits of eastern America for the following, among other reasons:

1. It requires a series of suppositions unlikely in themselves

and not warranted by facts. The most important of these is the coincidence of a wide spread continent and a universal covering of ice in a temperate latitude. In the existing state of the world it is well known that the ordinary conditions required by glaciers in temperate latitudes are elevated chains and peaks extending above the snow line; and that cases in which, in such latitudes, glaciers extend nearly to the sea level, occur only where the mean temperature is reduced by cold ocean currents approaching to high land, as for instance in Terra del Fuego and the southern extremity of South America. But the temperate regions of North America could not be covered with a permanent mantle of ice under the existing conditions of solar radiation; for, even if the whole were elevated into a table land, its breadth would secure a sufficient summer heat to melt away the ice, except from high mountain peaks. Either then there must have been immense mountain chains which have disappeared, or there must have been some unexampled astronomical cause of refrigeration as, for example, the earth passing into a colder portion of space, or the amount of solar heat being diminished. But the former supposition has no warrant from geology, and astronomy affords no evidence for the latter view, which besides would imply a diminution of evaporation militating as much against the glacier theory as would an excess of heat. An attempt has recently been made by Professor Frankland to account for such a state of things by the supposition of a higher temperature of the sea, along with a colder temperature of the land; but this inversion of the usual state of things is unwarranted by the doctrine of the secular cooling of the earth, it is contradicted by the fossils of the period, which show that the seas were colder than at present; and if it existed, it could not produce the effects required, unless a preternatural arrest were at the same time laid on the winds, which spread the temperature of the sea over the land. The alleged facts observed in Norway, and stated to support this view, are evidently nothing but the results ordinarily observed in ranges of hills, one side of which fronts cold sea water, and the other land warmed in summer by the sun.

2. It seems physically impossible that a sheet of ice, such as that supposed, could move over an uneven surface, striating it in directions uniform over vast areas and often different from the present inclinations of the surface. Glacier ice may move on very slight slopes, but it must follow these, and the only result of the immense accumulation of ice supposed would be to prevent motion altogether by the want of slope or the counteraction of opposing slopes, or to induce a slight and irregular motion toward the margins or outward from the more prominent protuberances.

It is to be observed, also, that, as Hopkins has shown, it is

only the *sliding* motion of glaciers that can polish or erode surfaces, and that any internal changes resulting from the mere weight of a thick mass of ice resting on a level surface, would have little or no influence in this way.

3. The transport of boulders to great distances, and the lodgment of them on hill tops could not have been occasioned by glaciers. These carry downward the blocks that fall on them from wasting cliffs. But the universal glacier supposed could have no such cliffs from which to collect, and it must have carried boulders for hundreds of miles, and left them on points as high as those they were taken from. On the Montreal Mountain, at a height of 600 feet above the sea, are huge boulders of feldspar from the Laurentide hills, which must have been carried from 50 to 200 miles from points of scarcely greater elevation, and over a valley in which the striæ are in a direction nearly at right angles with that of the probable driftage of the boulders. Quite as striking examples occur in many parts of this country. It is also to be observed that boulders, often of large size, occur scattered through the marine stratified clays and sands containing sea shells; and whatever views may be entertained as to other boulders, it cannot be denied that these have been borne by floating ice. Nor is it true, as has been often affirmed, that the boulder clay is destitute of marine fossils. At Murray Bay and St. Nicholas, on the St. Lawrence, and also at Cape Elizabeth, near Portland, there are tough stony clays of the nature of true "till," and in the lower part of the drift, which contain numerous marine shells of the usual Post-pliocene species.

4. The Post-pliocene deposits of Canada, in their fossil remains and general character, indicate a gradual elevation from a state of depression, which, on the evidence of fossils, must have extended to at least 500 feet, and on that of far-travelled boulders to nearly ten times that amount; while there is nothing but the boulder-clay to represent the previous subsidence, and nothing whatever to represent the supposed previous ice-clad state of the land, except the scratches on the rock surfaces, which must have been caused by the same agency which deposited the boulder clay.

5. The peat deposits with fir roots, found below the boulder clay in Cape Breton, the remains of plants and land snails in the marine clays of the Ottawa, and the shells of the St. Lawrence clays and sands, show that the sea, at the period in question, had much the temperature of the present Arctic currents of our coasts, and that the land was not covered with ice, but supported a vegetation similar to that of Labrador and the north shore of the St. Lawrence at present. This evidence refers not to the later period of the Mammoth and Mastodon, when the re-elevation was perhaps nearly complete, but to the earlier period con-

temporaneous with, or immediately following, the supposed glacier period. In my former papers on the Post-pliocene of the St. Lawrence, I have shown that the change of climate involved is no greater than that which may have been due to the subsidence of land and change of course of the Arctic current, actually proved by the deposits themselves.

These objections might be pursued to much greater length; but enough has been said to show that there are, in the case of northeastern America, strong reasons against the existence of any such period of extreme glaciation, as supposed by many geologists; and that if we can otherwise explain the rock-striation and polishing, and the formation of fiords and lake basins, the strong points with these theorists, we can dispense altogether with the portentous changes in physical geography involved in their views, and which are not necessary to explain any of the other phenomena.

It is on these points, more especially, that the Report of the Geological Survey throws new light; though Sir William, with his usual caution, has not committed himself to theoretical conclusions; and in one or two local cases he seems to favor the glacier theory. It has long been known to geologists, that in northeastern America, two main directions of striation of rock surfaces occur, from northeast to southwest, and from northwest to southeast; and that locally the directions vary from these to north and south, and east and west. Various attempts have been made, but without much success, to account for these directions of striation by the motion of glaciers; and while it is quite easy for any one prepossessed with this view to account in this way for the striation in a particular valley or part of a valley, so may exceptional facts occur as to throw doubt on the explanation, except in the case of a few of the smaller and steeper mountain gorges.

In the Report of the Survey of Canada, a valuable table of these striations is given, from which it appears that they are locally distributed in such a way as to throw a decided gleam of light on their origin.

It would seem that the dominant direction in the valley of the St. Lawrence, along the high lands to the north of it, and across Western New York, is northeast and southwest; and that there is another series of scratches running nearly at right angles to the former, across the neck of land between Georgian Bay and Lake Ontario, down the valley of the Ottawa, and across parts of the Eastern Townships, connecting with the prevalent southeast striation which occurs in the valleys of the Connecticut and Lake Champlain, and elsewhere in New England. What were the determining conditions of these two courses, and were they contemporaneous or distinct in time? The first point to

be settled, in answering these questions, is the direction of the force which caused the striæ. Now, I have no hesitation in asserting, from my own observations, as well as from those of others, that for the southwest striation the direction was *from the ocean toward the interior, against the slope of the St. Lawrence valley.* The crag and tail forms of all our isolated hills, and the direction of transport of boulders carried from them, show that throughout Canada the movement was from northeast to southwest.[2] This at once disposes of the glacier theory for the prevailing set of striæ; for we cannot suppose a glacier moving from the Atlantic up into the interior. On the other hand, it is eminently favorable to the idea of ocean drift. A subsidence of America, such as would at present convert all the plains of Canada, and New York, and New England, into sea, would determine the course of the Arctic current over this submerged land from northeast to southwest; and as the current would move *up a slope*, the ice which it bore would tend to ground and grind the bottom as it passed into shallower water; for it must be observed that the character of slope which enables a glacier to grind the surface, may prevent ice borne by a current from doing so, and *vice versâ*.

Now we know that in the Post-pliocene period Eastern America was submerged, and consequently the striation at once comes into harmony with other geological facts. We have of course to suppose that the striation took place during submergence, and that the process was slow and gradual, beginning near the sea and at the lower levels, and carried upward to the higher grounds in successive centuries, while the portions previously striated were covered with deposits swept down from the sinking land, or dropped from melting ice. It would be easy to show that this view corresponds with many of the minor facts.

Further, the facts thus ascertained account for the excavation of the deep and land-locked basins of our great American lakes. Ocean currents, if cold, and clinging to the bottom, must cut out pot-holes, just as rivers do, though geologists are too apt to limit their function to the throwing up of banks. The course of the present Arctic current along the American coast has its deep hollows as well as its sand-banks. Our American lake basins are cut out deeply into the softer strata. Running water on the land would not have done this, for it could have no outlet; nor could this result be effected by breakers. Glaciers could not have effected it; for even if the climatal conditions for these were admitted, there is no height of land to give them momentum. But if we suppose the land submerged so that the Arctic current flowing from the northeast should pour over the Lau-

[2] The few exceptional cases appear to belong mostly to the later period of the stratified sands.

rentian rocks, on the north side of Lake Superior and Lake Huron, it would necessarily cut out of the softer Silurian strata just such basins, drifting their materials to the southwest. At the same time, the lower strata of the current would be powerfully determined through the strait between the Adirondac and Laurentide hills, and flowing over the ridge of hard rock which connects them at the Thousand Islands, would cut out the long basin of Lake Ontario, heaping up at the same time, in the lee of the Laurentian ridge, the great mass of boulder-clay which intervenes between Lake Ontario and Georgian Bay. Lake Erie may have been cut by the flow of the upper layers of water over the Middle Silurian escarpment; and Lake Michigan, though less closely connected with the direction of the current, is like the others due to the action of a continuous eroding force on rocks of unequal hardness.

The predominant southwest striation and the cutting of the upper lakes demand an outlet to the west for the Arctic current. But both during depression and elevation of the land, there must have been a time when this outlet was obstructed, and when the lower levels of New York, New England and Canada were still under water. Then the valley of the Ottawa, that of the Mohawk, and the low country between Lakes Ontario and Huron, and the valleys of Lake Champlain and the Connecticut, would be straits or arms of the sea, and the current, obstructed in its direct flow, would set principally along these, and act on the rocks in north and south, and northwest and southeast directions. To this portion of the process I would attribute the northwest and southeast striation. It is true this view does not account for the southeast striæ observed on some high peaks in New England; but it must be observed that even at the time of greatest depression, the Arctic current would cling to the northern land or be thrown so rapidly to the west that its direct action might not reach such summits.

Nor would I exclude altogether the action of glaciers in eastern America, though I must dissent from any view which would assign to them the principal agency in our glacial phenomena. Under a condition of the continent in which only its higher peaks were above the water, the air would be so moist and the temperature so low, that permanent ice may have clung about mountains in the temperate latitudes. The striation itself shows that there must have been extensive glacers, as now in the extreme Arctic regions. Yet I think most of the alleged instances must be founded on error, and that old sea beaches have been mistaken for moraines. I have failed to find even in the White mountains any distinct sign of glacier action, though the action of the ocean breakers is visible almost to their summits; and though I have observed in Canada and Nova Scotia many old

sea beaches, gravel ridges, and lake margins, I have seen nothing that could fairly be regarded as the work of glaciers. The so-called moraines, in so far as my observation extends, are more probably shingle beaches and bars, old coast lines loaded with boulders, "trains" of boulders, or "ozars." Most of them convey to my mind the impression of ice-action along a slowly subsiding coast, forming successive deposits of stones in the shallow water, and burying them in clay and smaller stones as the depth increased. These deposits were again modified during emergence, when the old ridges were sometimes bared by denudation and new ones heaped up.

I shall close these remarks, perhaps already too tedious, by a mere reference to the alleged prevalence of lake basins and fiords in high northern latitudes, as connected with glacial action. In reasoning on this, it seems to be overlooked that the prevalence of disturbed and metamorphic rocks over wide areas in the north is one element in the matter. Again, cold Arctic currents are the cutters of basins, not the warm surface currents. Further, the fiords on coasts, like the deep lateral valleys of mountains, are evidences of the action of the waves rather than of that of ice. I am sure that this is the case with the numerous indentations of the coast of Nova Scotia, which are cut into the softer and more shattered bands of rock, and show in raised beaches and gravel ridges, like those of the present coast, the levels of the sea at the time of their formation.

LIBRARY OF THE UNIVERSITY OF MICHIGAN

ART. XXVII.—*On Celestial Dynamics*;[1] by J. R. MAYER.

THE surface of the sun measures 115,000 millions of square miles, or 6⅓ trillions of square metres; the mass of matter which in the shape of asteroids falls into the sun every minute is from 94,000 to 188,000 billions of kilograms; one square metre of solar surface, therefore, receives on an average from 15 to 30 grams of matter per minute.

To compare this process with a terrestrial phenomenon, a gentle rain may be considered which sends down in one hour a layer of water 1 millimetre in thickness (during a thunder-storm the rainfall is often from ten to fifteen times this quantity); this amounts on a square metre to 17 grams per minute.

The continual bombardment of the sun by these cosmical masses ought to increase its volume as well as its mass, if centrifugal[2] action only existed. The increase of volume could scarcely be appreciated by man; for if the specific gravity of these cosmical masses be assumed to be the same as that of the sun, the

[1] Extracted from the L. E. and D. Phil. Mag., [4], xxv, 399–402, and continued from vol. xxxvii, p. 198 of this Journal.

[2] [Centripetal?—TR.]

enlargement of his apparent diameter to the extent of one second, the smallest appreciable magnitude, would require from 33,000 to 66,000 years.

Not quite so unappreciable would be the increase of the mass of the sun. If this mass, or the weight of the sun, were augmented, an acceleration of the motion of the planets in their orbits would be the consequence, whereby their times of revolution round the central body would be shortened. The mass of the sun is 2·1 quintillions of kilograms; and the mass of cosmical matter annually arriving at the sun stands to the above as 1 to from 21 to 42 millions. Such an augmentation to the weight of the sun ought to shorten the sidereal year from $\frac{1}{42,000,000}$th to $\frac{1}{85,000,000}$th of its length, or from $\frac{3}{4}$ths to $\frac{3}{5}$ths of a second.

The observations of astronomers do not agree with this conclusion; we must therefore fall back on the theory mentioned at the beginning of this chapter, which assumes that the sun, like the ocean, is constantly losing and receiving equal quantities of matter. This harmonizes with the supposition that the *vis viva* of the universe is a constant quantity.

VII. *The Spots on the Sun's Disc.*

The solar disk presents, according to Sir John Herschel, the following appearance. "When the sun is observed through a powerful telescope provided with colored glasses in order to lessen the heat and brightness which would be hurtful to the eyes, large dark spots are often seen surrounded by edges which are not quite so dark as the spots themselves, and which are called penumbræ. These spots, however, are neither permanent nor unchangeable. When observed from day to day, or even from hour to hour, their form is seen to change; they expand or contract, and finally disappear; on other parts of the solar surface new spots spring into existence where none could be discovered before. When they disappear, the darker part in the middle of the spot contracts to a point and vanishes sooner than the edges, Sometimes they break up into two or more parts that show all the signs of mobility characteristic of a liquid, and the extraordinary commotion which it seems only possible for gaseous matter to possess. The magnitude of their motion is very great. An arc of 1 second, as seen from our globe, corresponds to 465 English miles on the sun's disk; a circle of this diameter, which measures nearly 220,000 English square miles, is the smallest area that can be seen on the solar surface. Spots, however, more than 45,000 English miles in diameter, and, if we may trust some statements, of even greater dimensions have been observed. For such a spot to disappear in the course of six weeks (and they rarely last longer), the edges, whilst approaching each other, must move through a space of more than 1000 miles per diem.

"That portion of the solar disc which is free from spots is by no means uniformly bright. Over it are scattered small dark spots or pores which are found by careful observation to be in a state of continual change. The slow sinking of some chemical precipitates in a transparent liquid, when viewed from the upper surface and in a direction perpendicular thereto, resembles more accurately than any other phenomenon the changes which the pores undergo. The similarity is so striking, in fact, that one can scarcely resist the idea that the appearances above described are owing to a luminous medium moving about in a non-luminous atmosphere, either like the clouds in our air, or in widespread planes and flame-like columns, or in rays like the aurora borealis.

"Near large spots, or extensive groups of them, large spaces are observed to be covered with peculiarly marked lines much brighter than the other parts of the surface; these lines are curved, or deviate in branches, and are called faculæ. Spots are often seen between these lines, or to originate there. These are in all probability the crests of immense waves in the luminous regions of the solar atmosphere, and bear witness to violent action in their immediate neighborhood."

The changes on the solar surface evidently point to the action of some external disturbing force; for every moving power resident in the sun itself ought to exhaust itself by its own action. These changes, therefore, are no unimportant confirmation of the theory explained in these pages.

At the same time, it must be observed that our knowledge of physical heliography is, from the nature of the subject, very limited; even the meteorological processes and other phenomena of our own planet are still in many respects enigmatical. For this reason no special information could be given about the manner in which the solar surface is affected by cosmical masses. However, I may be allowed to mention some probable conjectures which offer themselves.

The extraordinarily high temperature which exists on the sun almost precludes the possibility of its surface being solid; it doubtless consists of an uninterrupted ocean of fiery fluid matter. This gaseous envelope becomes more rarefied in those parts most distant from the sun's centre.

As most substances are able to assume the gaseous state of aggregation at high temperatures, the height of the sun's atmosphere cannot be inconsiderable. There are, however, sound reasons for believing that the relative height of the solar atmosphere is not very great.

As most substances are able to assume the gaseous state of aggregation at high temperatures, the height of the sun's atmosphere is not very great.

Since gravity is 28 times greater on the sun's surface than it is on our earth, a column of air on the former must cause a pressure 28 times greater than it would on our globe. This great pressure compresses air as much as a temperature of 8000° would expand it.

In a still greater degree than this increased gravity do the qualities peculiar to gases affect the height of the solar atmosphere. In consequence of these properties, the density of our atmosphere rapidly diminishes as we ascend, and increases as we descend. Generally speaking, rarefaction increases in a geometrical progression when the heights are in an arithmetical progression. If we ascend or descend $2\frac{1}{2}$, 5, or 30 miles, we find our atmosphere 10,100, or a billion times more rarefied or more dense.

This law, although modified by the unequal temperatures of the different layers of the photosphere and the unknown chemical nature of the substances of which it is composed, must also hold good in some measure for the sun. As, however, the mean temperature of the solar atmosphere must considerably exceed that of our atmosphere, the density of the former will not vary so rapidly with the height as the latter does. If we assume this increase and decrease on the sun to be ten times slower than it is on our earth, it follows that at the heights of 25, 50, and 300 miles, a rarefaction of 10, 100, and a billion times respectively, would be observed. The solar atmosphere, therefore, does not attain a height of 400 geographical miles, or it cannot be as much as $\frac{1}{240}$th of the sun's radius. For if we take the density of the lowest strata of the sun's atmosphere to be 1000 times greater than that of our own near the level of the sea, a density greater than that of water, and necessarily too high, then at a height of 400 miles this atmosphere would be 10 billion times less dense than the earth's atmosphere; that is to say, to human comprehension it has ceased to exist.

This discussion shows that the solar atmosphere, in comparison with the body of the sun, has only an insignificant height; at the same time it may be remarked that on the earth's surface, in spite of the great heat, such substances as water may possibly exist in the liquid state under a pressure thousands of times greater than that of our atmosphere.

Since gases, when free from any solid particles, emit, even at very high temperatures, a pale transparent light—the so-called *lumen philosophicum*—it is probable that the intense white light of the sun has its origin in the denser parts of his surface. If such be assumed to be the case, the sun's spots and faculæ seem to be the disturbances of the fiery liquid ocean, caused by most powerful meteoric processes, for which all necessary materials are present, and partly to be caused by the direct influence of

streams of asteroids. The deeper and less heated parts of this fiery ocean become thus exposed, and perhaps appear to us as spots, whereas the elevations form the so-called faculæ.

According to the experiments made by Henry, an American physicist, the rays sent forth from the spots do not produce the same heating effect as those emitted by the brighter parts.

We have to mention one more remarkable circumstance. The spots appear to be confined to a zone which extends 30° on each side of the sun's equator. The thought naturally suggests itself that some connexion exists between those solar processes which produce the spots and faculæ, the velocity of rotation of the sun, and the swarms of asteroids, and to deduce therefrom the limitation of the spots to the zone mentioned. It still remains enigmatical by what means nature contrives to bring about the uniform radiation which pertains alike to the polar and equatorial regions of the sun.

[To be continued.]

ART. XXVIII.—*On a supposed change of level in a part of the Green Mountains;* by W. K. SCOTT, M.D. From a letter, dated Buffalo, March 28, 1864, addressed to Prof. O. P. Hubbard, of Dartmouth College, Hanover, N. H.[1]

I HAVE ascertained some facts, or what I believe to be such, relating to a change of elevation in a part of the Green Mountain range, which I wish to be made known to the Vermont geologists that they may make a thorough investigation of them. But I do not know who these geologists are, and have no means of getting the subject before them. I have therefore concluded to make a general statement of these facts to you, presuming

[1] Dr. Scott addressed the following note (dated May 9th) to Prof. Hubbard, in reply to a request from the latter that he should permit the publication of the above letter.

"I have heretofore refused to have any thing published that I have written about Mount Anthony, until the hill, the mountain, and their surroundings had been thoroughly examined by some competent person. But as you advise it, I now give my consent. The publication may draw the attention of some experienced geologist to the subject, and thus bring about the investigation I have so long desired.

It is a short journey from Dartmouth to Hoosick, and if you should feel disposed to view the ground yourself, I will meet you there at any time, except in the winter and extreme heat of summer, by your giving me a few weeks' notice. After I have pointed out to you the localities and the changes which sixty years have produced, you could determine whether an expensive survey would be advisable. If you cannot conveniently come, you may induce some one else to do so.

I send you a copy of three letters which I have received on the subject, all from candid, sensible, and reliable men. I can procure another from the eldest daughter of Mr. L. Turner, if you think it would be well to do so. Yours, &c."

that you know these gentlemen and will be willing to communicate to them what I write.

In the year 1796, when I was eight years old, my father moved to a part of the town of Hoosick, Rensselaer Co., N. Y., known as Mapletown. His house was on the road from Bennington, Vt. to Troy, N. Y., near the Mapletown meeting-house, about four miles from the village of Bennington. The residence of the late Garret Van Hoosen is within a few feet of the site of that old house.

In front of that house was distinctly visible the top of Mount Anthony, a spur of the Green mountain, south of the old village of Bennington and very near it. What most attracted my boyish curiosity was a large white spot on the side of the mountain, which was said by the inhabitants to have been produced by the bursting of a cloud (as they called it), which washed away the earth and left the white rocks naked. This white spot was situated about one-eighth of the apparent height of the mountain from the top of it, and extended downward about one-fourth of its height.

In 1803, after having learned something about linear perspective, I made my first attempt at landscape painting in water colors. The view was taken from a front window in our house, and the picture embraced the whole of Mount Anthony which was visible from that point. I well remember how much trouble I had in representing the white spot on the mountain; and I remember, too, what a miserable failure the whole performance was.—I mention these things to show that my recollections are not vague and shadowy, but clear, distinct, and certain.

I left that place in January, 1808, after having finished a course of medical lectures at Dartmouth College. After an absence of fifty years, I visited it again to see my friend, Garret Van Hoosen, who lived, as I have before mentioned, within a few feet of my old home. During my journey there I thought almost as much about seeing Mount Anthony again, as seeing my old friend; but when I arrived there, no part of the mountain was visible.

In front of the house, about a quarter of a mile distant from it, is a hill, now called Russel Hill, over which the mountain was formerly seen. A part of the top of that hill is now covered with high trees, which were small bushes when I was a boy, and my first thought was that these trees hid the mountain; but the next morning after my arrival, as the sun was rising, I found that I could see between the trees, and that no mountain was there. By going about fifty rods toward Bennington, I got out of the range of the trees, and could look over a lower portion of the hill, which was cultivated, and see the top of the mountain, so low that it was certain that no part of it could be seen from the house if no trees were on the hill.

My first impression was that the whole of this change was due to the subsiding of the mountain; but reflecting how many feet it must have settled to be hidden from our view, I gave that up, and settled upon the opinion that Russel Hill must have risen, for one foot rise of that hill would hide twelve feet or more of the mountain.

Had I been a practical geologist, I should have sought for some evidence of its having risen; but knowing very little of that science, I could only glean a few facts obvious to every one.

The road in front of the house in question runs nearly north-east for about fifty rods, and then turns east and crosses the line of Russel Hill continued. I say the *line* of the hill, for the hill itself does not cross the road. Near where the road crosses that line is a stream, on which was a grist-mill in 1800. As it now is, there appears to me to be no fall that could be used for that purpose; and the owner of a meadow some sixty rods above the mill told me that that meadow was formerly a very rich and productive one—that the mill pond never set back far enough to injure it—but that now, when there was no dam, it was so wet as to be almost worthless.—Below the mill for many rods, when I was a boy, the water was still enough to be a convenient place for little boys to bathe in. Now, there is quite a fall there—enough to make a valuable water power.

Following the line of the crest of the hill across the road, we come to a barn-yard, belonging to the widow of Lyman Andrews, which, in 1800, was supplied with water brought from a spring some little distance west of it. The spring was enough higher than the barn-yard to give great velocity to the water, so that it made a whizzing noise in running from a small orifice. As nearly as I could ascertain with a carpenter's level, the barn-yard is now a little higher than the spring. My investigation was not thorough, for I had but little time, and it may be that the yard has been filled enough to make the difference, but I saw no evidence of it. A man by the name of H. B. Walworth lives in a house opposite to Van Hoosen's, who remembers all about the water in the barn-yard, and can show where the spring is and where the water was discharged; and he remembers as well as I do the great velocity of the little stream as it escaped from the penstock.

In a matter of so much interest to geologists, I thought it important to have the evidence of some one besides myself; for it would hardly be satisfactory to the public to rely entirely on the memory of one man. I found some difficulty in obtaining this, for the inhabitants of that district had changed many times in fifty years, and most of those who lived there when I did were dead or moved to parts unknown. There was, however, a man by the name of Lebbeus Turner, who lived there several years

and moved away about 1805, who was still living. He was a man of intelligence, and still retains his mental powers. He was a nailer, and had a house and shop near my father's house, on the opposite side of the road.

I wrote to him, asking if he remembered the white spot on Mount Anthony, and where he used to see it from. He answered[1] that he could always see it from his house, and described its shape and general appearance. He also said that he saw the storm on the mountain when the earth was washed away. This was before he lived in the neighborhood in question. His letter is quite interesting. I then made him a visit, and found that he and his wife were both clear in their recollections about it, and both certain that there could be no mistake about the mountain having been visible from their house. I had likewise an interview with his eldest son, Stillman Turner, who now lives in Worcester, Mass., and he is equally clear in his recollections. Mr. Turner's eldest daughter, too, remembers that the white spot on the mountain could be seen from their house. I have likewise a letter from Mr. Jacob Hallenbeck, who has lived all his life in another part of the town of Hoosick, and who was very often at Mr. Turner's shop, and he "thinks he remembers having often seen the mountain from that place." In a conversation with him after the letter was written, he spoke with absolute certainty of having seen the white spot from the back window of the shop.

All this appears to me to be sufficient evidence of the simple fact that Mount Anthony, and the white spot on the side of it, could be seen from my father's house and that vicinity, in the beginning of this century. All the rest is conjecture.

In order to ascertain how much the hill has risen, we must first find out how much higher the top of the mountain is than the bottom of the white spot, the distance from the mountain to the hill, and from the hill to the house; and all this will make quite a *job* of work. It is to be noted also that the white spot is not now visible from a distance, for it is covered with a growth of shrubs and small trees which have sprung up within the last thirty or forty years; but its boundaries can be easily traced, for so much earth was removed that a high bank was left at the sides and at the top of it.

If any geologist, whether employed by the State of Vermont or not, should deem this of sufficient importance to be worth a careful survey and a scientific investigation, and will undertake it, I shall take great pleasure in transmitting to him what I know about it, much more minutely than I have done in this communication, and to send him what letters I have received on the subject; and further, should he desire it, I will meet him on the

[1] His letter is given beyond, along with two from other observers.

spot and point out to him the various localities of which I have written. I should like, too, to have him see my witnesses and cross-examine them; for unless the evidence is strong enough to perfectly satisfy the public of the truth of my statements, I should not be willing to have any thing published about it.

And, furthermore, I think it would be well to have a permanent mark or monument placed on Russel Hill, and another at the house, showing the present difference in the elevation of these two points, so that in future it can be determined whether the hill continues to rise, and how much.

The following are copies of letters to Dr. Wm. K. Scott, attesting to the facts above stated.

"*Letter from Lebbeus Turner, of Aurora, Erie County, N. Y., dated East Aurora, Dec.* 17, 1855.

I received a few lines from you last Thursday, asking me to give you some information respecting Mount Anthony.

I well remember that when we lived in Mapletown the mountain was visible from our houses, and the white spot or streak on the side was plainly to be seen: the length of it went up and down the mountain. The mountain was seen some way below the spot; but for a number of years that spot has gradually filled up, and is now grown over with bushes of a size to obscure the spot. I presume the trees on the intervening hill have grown to a larger size than they were in those days, therefore I may justly conclude that Mount Anthony has not sunk down, nor the intervening hill risen to obscure the sight of that grand pile of rock and earth.

I well remember the time when that white spot was made. I was something like eight years old. At that time we lived on the Oak Hill, near where Miner Roberts lived. There was a very heavy thunder shower passed over the mountain from the southwest, so as to entirely obscure it; we could distinctly hear the rain roar; and as soon as the rain was over and the mountain was visible, that spot appeared. The neighbors at that time said that a cloud broke, and a large brook ran down the mountain.

My wife remembers well that the mountain was visible from our house.

[Signed,] LEBBEUS TURNER."

"*Letter from Jacob Hallenbeck, of Hoosick, N. Y., dated Hoosick, Sept.* 14, 1856.

You wish me to pen my recollections on the former appearance of Mount Anthony, and its present appearance from the place where Turner's shop used to stand. I think I can recollect some forty-five or fifty years ago, the mountain was plain to be seen from the place where the shop then was, but cannot be seen from that locality now, in consequence of the intervening hills. The mountain, hill, and plain where the shop stood, when viewed separately, have all the same appearance to me they ever had; but taken together, they present quite a different appearance from what they then did to me. I think there must be some alteration

in the form of the ground. I cannot believe it is owing to optical delusion, for I think I can see distant objects as well as I ever could.

[Signed,] JACOB HALLENBECK."

"*Letter from Stillman Turner, Esq., of Worcester, Mass., son of Lebbeus Turner, dated Worcester, April* 2, 1864.

Your communication is at hand, in which you wish me to state, according to my best recollection, whether Mount Anthony could be seen from my father's old residence in Hoosick, and also about the white spot on it. The most that I can say at this time is, that Mount Anthony was to me no rare sight to behold, for I think it was visible from almost any point in the vicinity of our old place. I certainly recollect seeing it when on the hill between our house and Uncle Harper Rogers', where we had a full view of the whole range of mountains east of us; I often used to stand and gaze with wonder and admiration on the scene; but whether it could be seen from our *house* or not, I am not able to say—certainly in that neighborhood I could see the white spot spoken of; but I do not feel justified in saying whether the mountain could be seen from our old residence or not. [Signed,] STILLMAN TURNER."

Note by Dr. William K. Scott.—From the hill of which Mr. Turner speaks, no part of the mountain is now visible. Nor can it be seen anywhere in that immediate neighborhood.

ART. XXIX.—*Notes on the Platinum Metals;* by M. CAREY LEA. Part. II. *On Reactions of the Platinum Metals.*

(III.)

REACTIONS OF HYPOSULPHITE OF SODA.

IN the first part of this paper I described the reaction of sesquichlorid of ruthenium with hyposulphite of soda, a substance which will probably be found to be the best touchstone which we have for detecting its presence. I shall now briefly describe the behavior of that reagent toward other metals of the group, and then proceed to examine how its behavior toward ruthenium is modified when one or more other metals are present in the same solution. The remarkable properties which the platinum metals possess of exhibiting in many cases reactions, when mixed, wholly different from those which they show separately, renders this a point of much importance.

The hyposulphite is to have a little ammonia added before using as already mentioned. The ammonia must be in sufficient quantity to ensure that the solution after the addition of the solution of the platinum metal shall be alkaline.

Bichlorid of Ruthenium and Ammonium gives, with hyposulphite of soda mixed with ammonia and boiled, a rich sherry-wine colored solution. This differs materially from the reaction

of ammonia alone, which produces a pale straw color—in both cases a very dilute solution is supposed to be used.

Sesquichlorid of Ruthenium.—As already described, a rich red purple by boiling; when dilute, nearly a rose color.

Bichlorid of Iridium and Ammonium.—Is simply decolorized.

Sesquichlorid of Rhodium.—Straw color, or yellow, according to strength of solution.

Bichlorid of Platinum.—The addition of hyposulphite of soda mixed with ammonia produces at first a precipitation of platinum salammoniac, which by heat (if the solution be not too strong) is redissolved to a yellow liquid. Boiling renders this at first paler, and almost colorless; the reaction then changes, and the color deepens to a rich wine brown.

Protochlorid of Palladium.—To apply the test to this metal, place a solution of hyposulphite in a test tube with a little liquid ammonia, and add a drop of palladium solution, so that it shall communicate a pale lemon color only, to the liquid. By boiling, this rapidly darkens to a wine brown shade, increasing in intensity until it finally appears black. Dilution however shows that this results from its intensity only; the diluted liquid is clear from troubling, and has a warm brown tint.

Detection of Ruthenium in Presence of Iridium by Hyposulphite of Soda and other Reagents.

For the following examinations, solutions of sesquichlorid of ruthenium and of chloriridiate of ammonium were used. Both in a state of perfect purity were weighed dry, dissolved, and mixed in the following proportions:

Ru_2Cl_3, 1 part; chloriridiate of ammonium, 10 parts.

The hyposulphite test was not in any way impaired by the presence of iridium.

Sulphocyanid test gave a red coloration, but much less clear than in the absence of iridium,[1] and much inferior to the reaction with hyposulphite.

Acetate of lead added and boiled gave a precipitate, in which the purplish shade characteristic of ruthenium was very evident.

Ru_2Cl_3, 1 part; chloriridiate, 20 parts.

Hyposulphite gave a perfect reaction.

Sulphocyanid, reddish brown coloration and unsatisfactory.

Acetate of lead gives a precipitate still distinctly colored by ruthenium. It is to be regretted that to judge cor-

[1] Claus remarks that this test fails when the Ru is in proportion to the Ir less than 1 to 10. As here the proportion is 1 of Ru_2Cl_3 to 10 of iridium salammoniac, the proportion of Ru is even less than 1 to 10 of Ir. The hyposulphite test is not in the least affected by even a much larger proportion of Ir.

rectly of this test, it is necessary, either to be very familiar with the color of the precipitate which the lead salt produces with a ruthenium solution, or else to prepare it for comparison.

Ru_2Cl_3, 1 part; chloriridiate, 50 parts.

Hyposulphite gave a perfect reaction.

Sulphocyanid having failed in a solution containing a larger quantity of ruthenium, was not here again tried.

Acetate of lead gave a precipitate which when carefully compared with that afforded by a perfectly pure iridium solution, exhibited a shade of difference, but scarcely sufficient to afford any criterion. At least, this must be regarded as the extreme limit of the sensibility of mixtures of Ru and Ir to this reagent.

Ru_2Cl_3, 1 part; chloriridiate, 100 parts.

Hyposulphite, perfect ruthenium reaction.

Ru_2Cl_3, 1 part; chloriridiate, 200.

Hyposulphite, satisfactory ruthenium reaction.

Ru_2Cl_3, 1 part; chloriridiate, 500 parts.

Even in the presence of such an enormous excess of iridium salt, ruthenium is capable of being detected by a practised eye by means of the hyposulphite test, although the clear rose color produced in the previous trials was here changed to an orange shade.

It may therefore be concluded that for the detection of ruthenium in the presence of iridium, the hyposulphite test is at least ten times more delicate than acetate of lead, and even much more so in comparison with sulphocyanid of potassium.

Dr. Gibbs has proposed a test for ruthenium by the use of alkaline nitrite and sulphid of ammonium. It was my wish to compare this method with that which I here describe, but I did not succeed in obtaining the reactions of which he speaks, although I tried both nitrite of potash, prepared by passing the red fumes evolved by the reduction of nitric acid through a potash solution, and also with nitrite of soda prepared from the nitrate.

In the first part of this paper I recommended that when solutions containing very little ruthenium were to be tested, they should first be boiled with a little pure chlorhydric acid. This is an important point, the neglect of which may cause the presence of ruthenium to be overlooked, when it exists in sufficiently large quantity to be recognizable, even by the ordinary tests, after this precaution has been taken.

After making the foregoing experiments, I had occasion, after an interval of some hours, to repeat them on the same diluted and mixed solutions, which had been preserved in closed phials.

I found no effect from hyposulphite. Selecting one containing sufficient ruthenium to render the sulphocyanid test available, I tried it; but equally without effect. The ruthenium had lost its power of reacting even in solutions which contained it in the proportion of $\frac{1}{20}$th of the iridium present. It was immediately suspected that in consequence of the dilution, it had become decomposed. A portion of the solution was then boiled with a little chlorhydric acid, when it at once recovered its sensibility to the various reagents.

It was long since pointed out by Claus that neutral solutions of sesquichlorid of ruthenium were decomposed by boiling with separation of oxyd of ruthenium, and that even without heat the separation took place by standing. But it appears that even acid solutions spontaneously decompose when very dilute, if the excess of acid present is small.

I therefore recommend that in all cases where it is intended to test solutions for small quantities of Ru, that the solution be heated with a little dilute chlorhydric acid immediately previous. Of course when the hyposulphite test is employed, the solution must be rendered alkaline with ammonia, after boiling with the acid, and before adding the hyposulphite. Generally speaking, it is advisable to use dilute solutions for testing for ruthenium. Although it is then present in smaller quantity, it is immediately recognizable, because its reactions are then less marked by the iridium than when stronger solutions are employed.

The decomposition of dilute solutions of ruthenium, even when acid, may easily be observed without the aid of reagents. When such a solution of Ru_2Cl_3 is very largely diluted with water, it soon assumes a purple black color, and after a few hours nearly the whole of the Ru falls to the bottom, leaving the liquid almost colorless. This I have found to take place in solutions containing Ru_2Cl_3, 1; water, 5,000.

When the solution is somewhat less largely diluted, it gradually assumes a purplish red color by standing, and then behaves for the most part differently with reagents than ordinary solutions of Ru_2Cl_3.

Detection of Ruthenium in Presence of Platinum by Hyposulphite of Soda.

Small quantities of Pt scarcely affect the ruthenium reaction. When larger quantities are present, the color produced is a mixture of that which would result from each separately, and therefore rather a wine, than a rose color.

Mixtures of Ir and Pt, or of Ru, Ir and Pt.

In all these mixtures, the reaction of the hyposulphite is that which would result from a mixture of the separate colorations.

The hyposulphite is a valuable test for the purity of iridium, and affords an easy indication as to whether other metals of the platinum group are present. Let the chloriridiate of ammonium be boiled with H Cl, and then ammonia be added until the solution assumes the pale olive color produced by alkalies in solutions of bichlorid of iridium. The solution should be sufficiently dilute that, after the ammonia has been added, it becomes nearly colorless. Now add the hyposulphite and boil. *If any increase of color whatever takes place, it is a certain indication of impurity.* If the liquid becomes rose color, ruthenium is present; if wine color, platinum is probably present; if brown, palladium is probably indicated.

(IV.)

REACTIONS WITH TETRATHIONIC ACID.

Tetrathionic acid is capable of giving useful reactions with metals of the platinum group, and especially with palladium.

Ru_2Cl_3 boiled with tetrathionic acid is somewhat decolorized, and finally becomes muddy and grayish.

$RuCl_2$ boiled with tetrathionic acid gradually darkens in color, becomes muddy, and finally throws down a brown precipitate. But if the acid be at first supersaturated with ammonia, the solution becomes yellow and remains clear.

Ir_2Cl_3, when boiled with tetrathionic acid, the pale, almost colorless dilute solution darkens rapidly, and by some moments boiling becomes a deep wine brown, remaining clear. If the acid be first supersaturated with ammonia, the reaction does not take place.

$IrCl_2$ is quickly decolorized by boiling with the acid. The decolorized solution does not darken by further boiling.

PdCl is instantly precipitated in the cold by tetrathionic acid. The precipitate has a dark chocolate brown color. This precipitation without heat is highly characteristic of the protochlorid of palladium, and the test is of great delicacy. A single drop of a rather dilute palladium solution was added to two ounces of water. In a few drops of this very dilute solution, the presence of palladium was made evident by this test. When the quantity of palladium present is so very minute as in this case, no precipitation takes place, but a brown coloration is developed. And as this coloration is produced in the cold, it is highly characteristic of the metal in question.

$PtCl_2$. Tetrathionic acid produces no effect in the cold. By boiling, a wine brown color is developed, but no precipitation takes place.

As this test for palladium appeared likely to be a valuable one, a series of experiments was undertaken to ascertain whether, like so many of the old tests for metals of the platinum group,

the reaction would be affected by the presence of other members of the group. Mixtures were therefore made of solution of protochlorid of palladium with the following substances respectively:

Sesquichlorid of ruthenium,
Bichlorid of ruthenium,
Sesquichlorid of iridium,
Bichlorid of iridium,
Bichlorid of platinum.

In all these cases it was found that the reaction was obtained without difficulty, so that this test is capable of detecting palladium with ease in the presence of either of the above-named compounds. When but little palladium is present, the reaction commences with a darkening of the solution, and the precipitate falls only after an interval of one or two minutes, or longer, according to the degree of dilution.

(V.)

REACTIONS WITH SULPHATE OF QUINIA.

With sulphate of quinia, protochlorid of palladium gives a bulky buff colored precipitate, which becomes somewhat blackish on boiling. Neither ruthenium nor iridium give similar reactions.

(VI.)

REACTIONS WITH PROTOCHLORID OF TIN.

Ru_2Cl_3 boiled with SnCl becomes perfectly colorless, if the solution is very dilute. Stronger solutions show a pale straw color.

$RuCl_2$, boiled with a small quantity of SnCl, gives a buff colored precipitate, which dissolves, in an excess of the precipitant, to a solution which, by further treating, passes to a splendid blood-red of great intensity.

The buff colored precipitate is soluble in solution of potash, producing an intense brown liquid.

Ir_2Cl_3. When the sesquichlorid of iridium and ammonium is boiled with SnCl, and potash added in sufficient quantity to redissolve the precipitate which it at first produces, further boiling produces an abundant leather-colored precipitate, which is insoluble in any excess of potash.

I felt much interested to observe whether this reaction would take place in the presence of sesquichlorid of ruthenium in the solution; and had the satisfaction to find that it did so. We thus have a mode of detecting iridium in the presence of ruthenium, which offers certain advantages.

The best way to observe the reaction is as follows: To the solution of sesquichlorid of ruthenium, add a little acidulated protochlorid of tin, and boil till the color disappears and then

add excess of potash. The liquid should be perfectly clear and very nearly colorless. The addition of a single drop of dilute solution of sesquichlorid of iridium communicates a yellow color, which rapidly deepens by boiling, and an abundant leather-colored precipitate falls. The almost perfect decolorization of the ruthenium solution by the protochlorid of tin, adds to the nicety of this reaction. Those only who have been annoyed by the extreme difficulty of getting any indication of the presence of small quantities of iridium in ruthenium solutions, will appreciate the full value of this test.

(VII.)

REACTIONS WITH AMMONIO-CHLORID OF ZINC.

A solution of clorid of zinc in excess of ammonia gives an interesting and beautiful series of reactions with the metals of the platinum group. The metallic solutions, which are to be subjected to this test, must be either neutral or slightly acid. The presence of alkali in excess, or of acid in large excess, naturally interferes with these reactions.

To obtain the zinc solution in proper condition, chlorid of zinc must be added to ammonia until the smell of ammonia becomes tolerably faint, and a considerable proportion of zinc oxyd remains undissolved. The liquid is then to be filtered off, and should be used without too much delay. In this condition the affinities are in a state of very unstable equilibrium. The addition of even a few drops of water produces a precipitate. It is precisely this instability which gives the solution its value for the purpose under consideration. When it is added to a solution of a platinum metal, the precipitate which falls carries with it a part or the whole of the platinum metal, which imparts to it a characteristic coloration.

The following are the reactions:

Ru_2Cl_3 a brown precipitate: the solution becomes colorless.

$RuCl_2$ a rose-colored precipitate: the solution becomes colorless.

Ir_2Cl_3 a pale buff precipitate: the solution becomes colorless, or nearly so.

$IrCl_2$ a fire-red precipitate: solution decolorized.

With platinum and palladium the tendency of ammonia to form double salts, interferes, and prevents any characteristic reaction from the zinc solution.

(VIII.)

REACTIONS WITH SOLUTION OF FERRIDCYANID OF POTASSIUM IN CAUSTIC SODA.

When this solution is added to ruthenium and iridium solutions, the following reactions are obtained:

Ru_2Cl_3—bright yellow liquid.

$RuCl_2$—the same, but more on a wine color.

Ir_2Cl_3. When to a slightly acid solution of sesquichlorid of iridium, enough of the solution in question is added to make the liquid strongly alkaline, a green coloration is produced at once, which by boiling becomes olive.

But if the iridium solution be first rendered alkaline with ammonia, the addition of the above reagent gives a bright yellow coloration, which by boiling becomes deep wine red.

(IX.)

REACTIONS WITH SCHLIPPE'S SALT.

A solution of Schlippe's salt mixed with an equal bulk of ammonia, and added to the solutions of the Pt. metals, gave the following reactions:

Ru_2Cl_3 by boiling, a blackish precipitate.

$RuCl_2$. When the solution containing the bichlorid of ruthenium is boiled, and a single drop of solution of Schlippe's salt added, a yellow transparent liquid is obtained. A larger addition gives an abundant light brick colored precipitate. When this larger quantity of solution of Schlippe's salt is added, a slight warming is sufficient to throw down the precipitate.

Ir_2Cl_3. A similar precipitate is obtained, but only after some minutes' boiling.

$IrCl_2$, is instantly decolorized by solution of Schlippe's salt with ammonia, and when boiled remains clear for a few minutes, then lets fall an abundant brick-brown precipitate. In this it is distinguished from $RuCl_2$, which lets fall the precipitate by a slight warming.

PdCl. As ammonia precipitates palladium at once, the following course was adopted. Ammonia was placed in a test-tube, and a little palladium solution added. Heat was applied till the precipitate, which at first formed, was redissolved. An addition of Schlippe's salt then produced an instantaneous and abundant brown black precipitate.

$PtCl_2$ treated with Schlippe's salt (without ammonia) gave an immediate dark brick-brown precipitate in the cold.

$KO\,OsO_3$. Osmite of potash, dissolved in dilute caustic potash, gives with the aid of heat an immediate black precipitate with Schlippe's salt.

The following substances gave no characteristic reactions with the platinum metals: fulminurate of ammonia, nitroprusside of sodium, picrate of ammonia, nitrosalycylate of potash, purpurate of ammonia, benzoic acid, chloranilamate of ammonia.

The new reactions which I have described in this paper include characteristic criteria for all those cases in which it has been considered most difficult to discriminate. Platinum and rhodium offer no difficulties; the first can always be recognized with ease by its behavior with chlorid of potassium, and the latter by its behavior with caustic alkalies. For the other metals, I propose here very briefly to recapitulate what I consider the chief points of interest here developed.

Ru_2Cl_3. The characteristic reaction of sesquichlorid of ruthenium is its beautiful coloration when boiled with *hyposulphite of soda*. See section third.

$RuCl_2$. Bichlorid of ruthenium is recognized by its rose-colored precipitate with *ammonio-chlorid of zinc*, as described in section seventh.

Ir_2Cl_3. } Iridium is best detected by its behavior with *proto-*
$IrCl_2$. } *chlorid of tin* and *potash*. The details and mode of application have been already described in section sixth.

PdCl. The reaction of protochlorid of palladium with *tetrathionic acid* is highly characteristic, and cannot well be confounded with any other. See section fourth.

For ascertaining the purity of solutions of iridium, particularly as respects ruthenium, the *hyposulphite of soda* is especially valuable, as described at the end of section third.

Philadelphia, May, 1864.

Art. XXX.—*Progress of the Geological Survey of California.*

Professor Whitney, having recently returned from California, is now engaged in superintending the publication of a portion of the materials collected by the Geological Survey of California. He communicates the following statement in regard to the present condition and probable future of the Survey:—

Those interested in the California Survey will already have learned something of its progress from the brief reports, or letters to the Governor of that State, which have appeared from time to time, during the past three years, and of which extracts or notices, more or less complete, have appeared in this Journal. (See Journal for July, 1863, and May, 1864.)

No serious opposition has been made to the continuance of the Survey, during any of the Legislative sessions, except on the score of economy, an argument which was urged with more reason than usual before the last Legislature; since, owing to a variety of causes, which it is not necessary here to specify, the finances of the State, for the past three or four years, have been in a deplorable condition. The vast extent of area to be explored, the variety of subjects claiming attention, and the necessarily heavy expense of travelling everywhere on the Pacific slope, make it impossible to carry on this work with anything like satisfaction, even with appropriations which would be deemed ample on the Atlantic side

of the continent. The heavy and entirely unprecedented rains of the winter of 1861–2, and the equally unprecedented drought which has prevailed since that time, have been great obstacles to the progress of the field-work, partly by impeding communication, and partly by increasing the price of provisions and forage, so that the field-expenses have been double or triple what they would have been in ordinary seasons.[1]

The sessions of the Legislature being, under the new Constitution of the State, which has come in force, biennial, at the last session an appropriation was made for the two fiscal years commencing July 1st, 1864. The sum appropriated for the continuance of the Survey for two years was $31,600;[2] of which, however, $6000 was to be set apart for the publication of two volumes of the Report, making, with $3000 previously appropriated for that purpose, $9000 available for printing and engraving—or, rather, which will be available when the money is received from the Treasury.

The old law organizing the Survey having expired by constitutional limitation, a new one was passed, somewhat modifying the details of the work, and especially in regard to the method of publication. The Act, the essential portion of it at least, is worded as follows: "It shall be his (the State Geologist's) duty, with the aid of such assistants as he may appoint, to complete the geological survey of the State, and to prepare a report of said survey for publication. Such Report shall be in the form of a geological, botanical, and zoological history of the State," &c.

In accordance with the Act now in force, it is presumed that the Survey will be continued for four years longer; and it is the intention of the State Geologist to close it up within that time, at least the active field-work, if spared to continue it so long.

The appropriation being so small, for the next two years the work will necessarily be continued on a rather small scale; but it is thought that, if the State returns to its normal condition of prosperity, the extreme disturbing influences of the past three years passing away, a liberal appropriation will be made by the next Legislature for closing up the work and for the publication of its results.

Following the provisions of the present Act, each volume of the Reports now and hereafter to be published will form a part of the Final Report, which it is believed will comprise about ten large royal-octavo volumes.

The first volume to be issued will comprise the first installment of the Paleontology of the State. It will be illustrated by 32 crowded plates on steel and stone, which have been for some time in the hands of the engravers, and of which the accompanying text is now passing rapidly through the press.[3]

[1] Professor Brewer, now in charge of a party exploring in the central portion of the Sierra Nevada, in a letter recently received, describes the journey from San Francisco to Visalia, through Pacheco's Pass, and across the plain of the San Joaquin, as one of great hardship, owing to the extreme difficulty of procuring water or forage along the whole route.

[2] It will be observed that *gold* is the only circulating medium in California.

[3] As the engraving of the plates will still require some time, the letter-press, which will soon be completed, will be issued by itself, in a limited number of copies, to which the plates will be added on their appearance.

This volume includes the Carboniferous, Triassic, Jurassic and Cretaceous fossils; the Carboniferous and Jurassic by Mr. Meek, the Triassic and Cretaceous by Mr. Gabb. Of the Cretaceous fossils 249 new species are described, from a formation not distinctly recognized in California previous to the commencement of this survey; but now known to extend through the State from one end to the other, and indeed from Mexico to British Columbia, and to be in many localities rich in well-preserved fossils.

The second volume of the Paleontology of California will be devoted to the Tertiary formation, and to such additions to what had already been done in the lower formations as may have been accumulated during the continuance of the Survey.

Immediately after the appearance of the first volume above-mentioned, a second will be put to press, which will be devoted to the General Geology of California. This volume, it is hoped, may be issued early in the next year. In a third volume, which will follow soon after the appearance of the second, it is proposed, although not definitely determined, to make a beginning with the Zoological history of the State.

A party is now in the field, in charge of Professor Brewer, engaged in exploring the region of the high Sierra Nevada, south of the Mono Pass and the region examined last year: a portion of the State which is almost entirely unexplored, and of which we know only that it contains some of the loftiest and most extensive mountain-groups of the Sierra.

Some of the principal results of the Survey, up to the present time, may be thus briefly summed up:

1. *Topography.*—For a sketch of what had been done in this department up to the beginning of the season for field-work in 1863, see this Journal, vol. xxxvi, p. 119. During that season a reconnoissance was made in the High Sierra, from the region adjacent to the Mono trail (which trail leads from Big Oak Flat or Coulterville, along the edge of the Yosemite valley, to Aurora, a little south of the 38th parallel of latitude) to the northern line of the State. Nearly all the high points of the Sierra Nevada, on this line of reconnoissance, were ascended and measured barometrically. The highest portion of the Sierra Nevada is that near the head-waters of the Tuolumne river, west and southwest of Mono Lake. The culminating peak of the Sierra, the highest point in the State, with the exception of Mt. Shasta, we found to be just north of the Mono trail, eight miles southwest of Mono Lake; it is 13,200 feet high, and, being one of the numerous unnamed peaks of the Sierra, was called by us Mount Dana, in honor of Professor J. D. Dana. The next point in height to this—the centre of a magnificent group of snow-covered peaks—we named Mount Lyell: it is about 15 miles, a little west of south, from Mt. Dana, and about 100 feet lower than that elevation. The scenery of this portion of the Sierra is truly Alpine, and can hardly be surpassed in grandeur.

One of the most interesting facts observed here, for the first time in the Sierra, was the proof everywhere surrounding us of the former existence of glaciers, on an immense scale of magnitude. All the phenomena of former glacier action are exhibited to the greatest advantage in the upper Tuolumne valley, through which once flowed a mass of ice nearly 1000

feet in thickness. Thousands of acres of granite retain the most exquisite glacial polish, and the existence of lateral, medial, and terminal moraines is as easily observed as in the Alps at the present day.

These traces of extinct glacier action were afterward discovered by us in many other places to the north of this, through to Mt. Shasta.

The work of laying down the topography will be continued during the present season by Mr. Hoffman in the region south of the Mono trail, and by Mr. Wackenreuder in that north from Silver Mountain to the Henness pass. Thus our observations, when combined, will enable us to give the first approach to a tolerably accurate map of this great chain of mountains. It is uncertain, as yet, how and in what form our topographical work will be laid before the public, except that the publication of the maps of the vicinity of the Bay of San Francisco and of the Monte Diablo region has been determined on, and they will be soon placed in the engravers' hands. It is believed, however, that such arrangements will be made as shall ensure the publication of a map of the entire State, greatly improved on anything which has yet appeared, and as large as can be conveniently used for a wall-map—say, on a scale of twelve miles to the inch. A map of the central portion of the State, on a scale of about six miles to the inch, embracing the principal mining regions, and covering the area occupied by at least four-fifths of the population of the State, will also probably form a part of the materials prepared for publication by the Survey.

2. *Physical Geography.*—Observations in this department have been steadily carried on during the progress of the Survey, and one of the volumes of the Report will be devoted to this department of our work. Allusion may be made here to the very important investigations which have been carried on in California, for some years past, by Major R. S. Williamson, U. S. Engineers, on the laws governing the fluctuations of the barometer on the Pacific coast. These investigations, for which small amounts have been appropriated by the Topographical Bureau, and which have been prosecuted by Major Williamson with the greatest zeal, will, when their results are published, be of material aid to the Geological Survey, and we shall be able to use them in the final working up of our own very numerous hypsometrical observations. The data collected in the course of these investigations have been employed by Major Williamson in working up the observations taken by the U. S. and California Boundary Commission in 1861, in and near Death's Valley, enabling him to fully confirm and give a scientific basis to the idea previously vaguely entertained, that this remarkable valley, which is 180 miles from the Pacific and which may be compared to that of the Dead Sea of Palestine, is indeed considerably depressed below the level of the ocean.

3. *Geology.*—Up to the present time, and including this season of field-work, we may be said to have been chiefly engaged in making a general geological reconnoissance of the State, and we have travelled very extensively over it, in all directions. But considerable areas remain, for various reasons, yet unexplored. The northwestern counties have remained inaccessible on account of Indian troubles; and portions of the southeastern for the same reason—with the additional one, that the drought has seriously interfered, for the last two years, with operations in that quarter.

In addition to work carried on within the boundaries of California, we have considerably extended the area of our field of labor by observations made in the adjacent territories, and not considered, or paid for, by the State as part of the regular work of the Survey. Mr. Gabb was employed by me, in the autumn of last year, to make a reconnoissance in Oregon and Washington Territory, and also on Vancouver Island, where he made important additions to the little previously known of the geology of that region. He has now joined an exploring party through southeastern Oregon, emphatically a geological *terra incognita*, and from which region he can hardly fail to bring back geological facts of importance. The expedition was to start from Fort Klamath, on the north end of Klamath Lake, about the 15th of June. Mr. Clarence King made, during the early part of the present season, some important explorations in the Humboldt range, and the ranges east of that, in Nevada Territory. Mr. Rémond has been for some time in Sonora, Mexico, and has made interesting discoveries, which will enable us to prove the continuance of the geological formations of California far to the south, and which connect with our line of observation, so as to form a chain—broken at many points, it is true—of about 2000 miles in length. It may here be added, as an important item in the development of the geological structure of the western side of the continent, although not connected with the Geological Survey of California, that Baron Richthofen, the eminent geologist formerly attached to the Reichsanstalt, or Austrian Geological Survey, has been for some time engaged in investigating the geology of the Pacific coast, and that he is specially devoting himself to the study of the Washoe region; those who have consulted this gentleman's publications on the districts examined by him in the Alps, especially in Tyrol, and also in Hungary, will not need to be told that whatever he may give to the world in regard to this, in many respects, strikingly similar region of Nevada Territory, will be of the greatest interest.

On the whole, it may be said that the labors of the past three, and of the coming four, years can hardly fail to furnish us with the means of giving a tolerable approximation to a geological map of the Pacific coast of our continent, and one, it may be added, which will have little resemblance to those which have heretofore been published. For anything like a detailed knowledge of the whole of this vast, mountainous, and extremely difficult region, we shall have to wait many years.

In alluding to a few of the results of the Geological Survey in this department, it will be necessary to be extremely brief; for, even if this were a suitable place for it, details would hardly be intelligible without maps and sections.

Perhaps the most striking result of the Survey is the proof we have obtained of the immense development, on the Pacific side of our continent, of rocks equivalent in age to the Upper Trias of the Alps, and paleontologically closely allied to the limestones of Hallstadt and Aussee, and the St. Cassian beds, that extremely important and highly fossiliferous division of the Alpine Trias.

This great Triassic belt of the Pacific coast has been most fully explored by the Survey in the latitude of 40°, and over a width east and west of nearly four degrees of longitude (117° to 121°). It is from this

region that the largest portion of the fossils have been obtained, both from the three parallel ranges in long. 117° to 118°, called the Humboldt ranges, and from localities in Plumas county, California. But sufficient paleontological evidence has been obtained to enable us to state that this formation extends from Mexico to British Columbia, occupying a vast area, although much broken up, interrupted, and covered by volcanic and eruptive rocks, and usually highly metamorphosed.

Among the specimens from the Humboldt and Plumas county, Mr. Gabb recognizes at least four species as identical with European, while the whole facies of the collection is most strikingly like that of the Hallstadt beds—the same intermixture of orthoceratites, ceratites, goniatites, nautili and ammonites, the latter frequently of those peculiar globose forms occurring in the Alps, together with *Halobia*, *Monotis*, *Avicula*, *Pecten*, &c., a *Monotis* being the most widely diffused and the most abundant of all.

Accompanying this Triassic formation in the Sierra Nevada, and probably also in the Humboldt ranges, is an extensive development of Jurassic rocks, usually highly metamorphosed and extremely barren of fossils. Enough, however, have been found to justify the assertion that the sedimentary portion of the great metalliferous belt of the Pacific coast of North America is chiefly made up of rocks of Jurassic and Triassic age, with a comparatively small development of Carboniferous limestone, and that these two formations are so folded together, broken up, and metamorphosed in the great chain of the Sierra Nevada, that it will be an immense labor, if indeed possible at all, to unravel its detailed structure. While we are fully justified in saying that *a large portion of the auriferous rocks of California consist of metamorphic Triassic and Jurassic strata*, we have not a particle of evidence to uphold the theory that has been so often maintained, that all, or even a portion, of the auriferous slates are older than the Carboniferous; not a trace of a Devonian or Silurian fossil even having been discovered in California, or indeed anywhere to the west of the 116th meridian. On the other hand, we are able to state, referring to the theory of the occurrence of gold being chiefly limited to Silurian rocks, that this metal occurs in no inconsiderable quantity in metamorphic rocks belonging as high up in the series as the Cretaceous.

Allusion has already been made to the wide-spread occurrence in California of the Cretaceous formation. The coast-ranges of California and Oregon, indeed, are to a large extent made up of rocks of this age, usually more or less metamorphic in their condition, and frequently highly so; but still, on the whole, forming the richest fossiliferous formation of the State, having already yielded fossils at over thirty localities. According to Mr. Gabb, it appears that the formation, so far as is yet known, is represented on the Pacific coast by but a single member—the upper, or white chalk; and that it may be divided into two well-marked groups, the lower of which corresponds to the No. 4 of Meek and Hayden, or the Fort Pierre group. This division (Div. A of the California Report) has yielded 152 species in California, out of about 260 collected, and of these only about half a dozen are common to this and the upper division (Div. B). This latter should probably, judging from its stratigraphical position, correspond with the Fox Hill group, or No. 5 of Meek and Hayden;

although all the species, with a single doubtful exception, are peculiar to California, and that species is referred to one described from No. 4 in New Jersey and Tennessee.

Rocks of Tertiary age are extensively developed in the coast ranges, although not so much so as the Cretaceous, the greatest development of the former being in latitude about 34° and 35°. Although fossiliferous in many localities, the Tertiary beds do not usually retain their organic remains in as good a state of preservation as the Cretaceous, and there is a much greater variety of distinct groups of species. The paleontology of the Tertiary rocks has not yet been thoroughly worked out, but it will be taken up by Mr. Gabb during the coming winter. It will probably require a long period of time before the Tertiary of the Pacific coast will be wholly elaborated, and the exact equivalency of its divisions with those of the Eastern Tertiary be made out.

In regard to the relative ages of the different mountain-chains of the Pacific coast, a few words may be added, premising that this subject will be as fully discussed as our materials will admit, in the Report.

There can be no doubt that the chain of the Sierra Nevada is older than the Rocky Mountain chain, or that group of chains or ranges which forms the eastern border of the great mountain region of the western side of the continent. The great mass of the Sierra was uplifted and metamorphosed after the termination of the Jurassic epoch, and prior to the deposition of the Cretaceous, for we find the last-named formation resting horizontally and unaltered on the flanks of the Sierra, all through Central California. The same statement is probably true with regard to the ranges east of the main crest of the Sierra Nevada, as far at least as the 116th meridian. But, although we have good reason to believe that these last-mentioned ranges were uplifted and metamorphosed after the close of the Jurassic period, we have not positive evidence that this took place prior to the Cretaceous epoch. Still, combining all we know of the geology of New Mexico and Nevada Territory, there appears to be little doubt that the system of the Sierra Nevada extends over a considerable area, east and west, embracing a number of nearly parallel ranges of mountains, some of which, indeed, are little inferior in extent and elevation to the Sierra Nevada proper.

We have recognized at least three distinct periods of upheaval and metamorphic action in the coast-ranges. The main one was at the close of the Cretaceous epoch; the next in importance was after the deposition of the Miocene tertiary—or, at least, of a group of strata which, for the present, may be referred to that age. The next in age is a system of east and west upheavals, which took place at the close of the Miocene; and the third is one which appears to have commenced during the later Pliocene, and to be still going on.

It is a very interesting fact, that the exterior of the coast-ranges—that is to say, the mountains nearest the Pacific—are of earlier date, or older geologically, than the interior ones, or those which border the Sacramento and San Joaquin valleys. This is a repetition on a smaller scale of what has been the course of events in the formation of the whole continent, the exterior lines having been first marked out, and the interior filled up afterwards.

The vast Tertiary formations on the flanks of the Sierra Nevada, so important as being the locality of the hydraulic mining operations, are not of marine origin, as has been so often asserted. The history of these deposits, their position, age, and other characters, are exceedingly interesting; but it is impossible, in this connection, to do more than hint at some of their main features.

There is perhaps no subject connected with the geology of the Pacific coast, in regard to which there are so many misapprehensions, as there are in what has been published by geologists on the nature and distribution of the detrital deposits which are so extensively worked by the methods known as hydraulic and tunnel mining. It has been assumed that these deposits are of marine origin, and that they originally extended over the whole western slope of the Sierra Nevada, a condition of things which, were it true, it would be of vast importance for California to know; but the real facts of the case are entirely different.

In the first place, these deposits are not of marine origin, as is proved by the fact that, although frequently found to contain impressions of leaves, masses of wood and imperfect coal, and even whole buried forests, as well as the remains of land animals, and occasionally those of fresh water, not a trace of any marine production has ever been found in them.

Again, these detrital deposits are not distributed over the flanks of the Sierra in any such way as they would have been if they were the result of the action of the sea. On the contrary, there is every reason to believe that they consist of materials which have been brought down from the mountain-heights above and deposited in preëxisting valleys: sometimes in very narrow accumulations, simple beds of ancient rivers, and at other times in wide lake-like expansions of former water-courses; and this under the action of causes similar to those now existing, but probably of considerably greater intensity. This deposition of detritus, for the most part auriferous, took place during the later Pliocene epoch, and not as late as the drift or diluvial period, as is abundantly proved by the character of the remains of plants and land animals which are imbedded in it.

The deposition of this auriferous detritus was succeeded, throughout the whole extent of the Sierra Nevada, by a tremendous outbreak of volcanic energy, during which the auriferous gravel was covered by heavy accumulations of volcanic sediments, ashes, pumice, and the like, finally winding up by a general outpouring of lava, which naturally flowed from the summits of the Sierra through the valleys, into the lake-like expansions, filling them up and covering over the auriferous gravels, which were to remain for ages, as it were, in a hidden treasure chamber, concealed under hundreds of feet in thickness of an almost indestructible material.

The effect of the denudation which has taken place since these streams of lava flowed down the mountains, has been most extraordinary. For now, these deposits of gravel and overlying volcanic materials, instead of occupying the depressions of the surface, are found forming high plateaux between the present river cañons and flat-topped ridges, known as "Table mountains," hundreds, or even thousands, of feet above the present river beds. Thus the topography of the country is exactly the reverse of what

it was at the commencement of the present geological epoch: what were once valleys are now ridges, and the ridges of former times were where the immense cañons of the rivers flowing down the western slope of the Sierra now are. The proof of this assertion, and the interesting bearing it has on the tunnel and hydraulic mining interests of California, will be fully set forth in the Reports of the Survey.

The Mammalian remains found in the tunnel and placer diggings of California seem to belong to two distinct epochs. The oldest represents the Pliocene, the other the Post-tertiary. The former are found under the volcanic beds, the latter in deposits which have been formed since the period of greatest volcanic activity, and which apparently belong to the epoch of Man. For it appears that the facts collected by this Survey, when fully laid before the public, will justify the assertion *that the mastodon and elephant, whose remains are so widely and abundantly scattered through California, have been contemporaneous with Man in that region.*

The above are a few of the more interesting facts developed by the Geological Survey of California, and of which the full details will be laid before the scientific public with as little delay as possible.

4. *Metallurgy and Mining.*—Particular attention will be paid to these departments of the Survey during its continuance, and no pains will be spared to throw all possible light on the mode of occurrence of the valuable metals and ores, the method of working them, and the processes now in use on the Pacific coast. It is estimated that two volumes will be required for this division of the Report.

5. *Botany.*—It is believed that the progress in this department, under Prof. Brewer's direction, has been sufficient to warrant the assertion that a "Manual of the Botany of California" will form a portion of the work of the Survey. The large collections of plants already made have been distributed to different high authorities in each department, and Prof. Brewer expects to return to the East in a short time, to commence the preparation of such a work as, it is believed, will be a most important help to the study of the botany of the Pacific coast.

6. *Zoology.*—The working up of the zoological collections of the Survey is now in progress under Dr. Cooper's direction. It has not yet been decided how many volumes will be required for their full description and illustration.

The publication of so large a mass of materials will necessarily occupy several years, and it will of course depend on the action of future Legislatures how fully and how rapidly our results are laid before the public in a printed form. Three volumes are already provided for, and, as has been already stated, they will be sold at a moderate price, and the proceeds, as required by law, paid over to the common school fund of the State.

J. D. Whitney.

Northampton, Mass., Aug. 1, 1864.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On a new class of Sulphur compounds.*—Von Oefele has succeeded in shewing that sulphur, like selenium, tellurium, lead, tin and many other elements, is capable of forming a true organic base with ethyl, and doubtless, therefore, with other organic radicals. The iodid of the new radical is easily formed by the direct combination of sulphid of ethyl with iodid of ethyl, the reaction being expressed by the equation

$$2C_4H_5S + C_4H_5I = (C_4H_5)_3S_2I.$$

The new iodid is a beautiful crystalline body which is easily soluble in water and alcohol and crystallizes from its solutions unchanged. Nitrate of silver precipitates iodine from an aqueous solution of iodid of triethyl-sulfyl as iodid of silver, while a nitrate of the new base remains in solution. Oxyd of silver and water digested with the iodid yield the hydrated oxyd of triethyl-sulfyl, which in the exsiccator gives transparent deliquescent crystals. The oxyd of triethyl-sulfyl is a very powerful fixed base, a solution of which exhibits a strong alkaline reaction and precipitates metallic oxyds from their solutions like caustic potash. It forms neutral salts with acids; the sulphate and nitrate are crystalline and deliquescent. The chlorplatinate $(C_4H_5)_3S_2Cl, PtCl_2$ crystallizes easily from the aqueous solution in long prisms. The author is engaged in investigations which appear to show that nitric acid converts triethyl-sulfyl into a new base which contains S_2 as a hexatomic instead of a tetratomic element, the hydrated oxyd being probably $\{(C_4H_5)_3S_2O_2\}O, HO$, and which perhaps still possesses weak basic properties.—*Journ. of the Chemical Society of London*, xi, 105. W. G.

2. *On a very sensitive reaction for Iron.*—Natanson has observed that sulpho-cyanid of iron is soluble in ether, and that when a solution containing a trace of peroxyd of iron and sulpho-cyanid of potassium but exhibiting no visible red tint is agitated with ether, the latter assumes a rose color resembling that produced in chloroform by traces of iodine. Of course the precautions usual in testing for iron by sulpho-cyanid of potassium must be taken in employing Natanson's process. By means of it, the author easily detected iron in a solution of chlorid of platinum, in which, on account of the yellow color, sulphocyanid of potassium as usually employed, produces no sensible change of color. W. G.

3. *On the conversion of mono-carbon acids into the corresponding more highly carbonated di-carbon acids.*—Kolbe and Müller, independently of each other, have succeeded in preparing malonic from acetic acid, and the latter chemist has also obtained succinic from propionic acid by the same process. When mono-chloracetic acid is heated with a solution of cyanid of potassium it is easily decomposed and yields cyanacetic acid, and chlorid of potassium. Chloracetic ether undergoes a precisely similar change when boiled with an alcoholic solution of cyanid of potassium, cyanacetic ether being formed. When cyanacetic acid is boiled with a large excess of potash, ammonia is given off and malonate of pot-

ash is formed, from which pure malonic acid is easily obtained. Kobel represents the reaction in this case by the equation

$$KO, C_2\left\{\begin{matrix}H_2\\C_2N\end{matrix}\right\}[C_2O_2]O+KO.3HO=2KO.[C_2H_2)''\left[\begin{matrix}C_2O_2\\C_2O_2\end{matrix}\right]O_2+H_3N.$$

Müller obtained the same results by boiling cyanacetic ether with caustic potash, while by treating chloro-propionic acid by the same process a small quantity of a crystalline acid was prepared, which on being heated, emitted the suffocating vapor characteristic of succinic acid. Both authors promise a further investigation of this very interesting subject.—*Journal of the Chemical Society*, Ser. 2, vol. xi, p. 109. W. G.

4. *On Thallium.*—CROOKES has published the first part of a monograph of thallium, in which all the known facts in regard to this metal are collected and systematically arranged. For the details, many of which have already appeared in this Journal, we must refer to the original paper. We design at present only to notice a single point, the relations, namely, of thallium to the alkaline metals. Crookes maintains that it belongs to the same group with silver and lead, (sic) a view which, as he says, is generally taken in England. It seems difficult to understand how any chemist at the present day can place lead and silver in the same natural group, silver being monatomic while lead is either diatomic or tetratomic according to circumstances. All the relations of thallium show plainly that it is essentially monatomic, and the very interesting discovery by Church of a silver alum only illustrates the analogy between silver and the alkaline metals which are also monatomic. That potassium and silver are at different ends of the scale, so far as their electrical relations are concerned, is of no consequence whatever in determining their natural position with respect to each other, since the difference is one of degree and not one of kind. As gold with the equivalent 197 is also monatomic, we may expect hereafter to discover a gold-alum or at least a salt in which gold and potassium may replace each other isomorphously. It appears to us, after a careful examination of all the facts, incontestible that thallium, like potassium and silver, belongs to the monatomic group of elements, and that in its chemical relations it forms a connecting link between these two metals which is of the greatest interest and value for the purposes of classification. Further investigation may perhaps show that indium, which like thallium and the alkaline metals gives a single spectral line at moderate temperatures, belongs to the same group. W. G.—*Journal of the Chemical Society*, Ser. 2, xi, 112.

5. *On Cobaltic acid.*—WINKLER has observed that when finely divided metallic cobalt is heated with a strong solution of caustic potash, a deep blue solution is formed which proves on analysis to be a cobaltate of potash. Cobaltic acid has the formula CoO_3, and belongs therefore to the group of manganic, ferric and chromic acids. The blue solution is only formed and only exists in the presence of a large excess of caustic potash: deoxydizing agents and even the addition of a large quantity of water easily decompose it. Ether does not dissolve cobaltate of potash but forms a brown zone where the solutions are in contact, while, on shaking, the cobalt solution becomes brown and deposits a hydrate of the sesquioxyd. The author thinks that this reaction may be used as a test for cobalt. W. G.—*Journal für prakt. Chemie*, xci, p. 213 *and* 351.

6. *New method of reduction especially applicable to a large number of metals.*—Mr. Poumarède has proposed to use the vapor of zinc as a reducing agent, and has obtained by this means a large number of interesting products. Peligot exhibited to the Academy of Sciences, at its session, March 28, specimens of nickel and cobalt thus made, and also magnificent crystals of iron.

7. *Bromid of potassium, a powerful narcotic.*—Bromid of potassium after having been used as a remedy against diphtheria, photophobia, etc., has been proved to be a powerful narcotic. It produces its effects without any cerebral congestion, and therefore without either pain in the head or constipation, and it has therefore great advantages over opium.

8. *Elements of Chemistry, Theoretical and Practical;* by William Allen Miller, M.D., LL.D, &c. Part I, *Chemical Physics.* From the third London edition. New York, John Wiley. 1864. 512 pp. 8vo.—We had occasion in a late No. of this Journal to notice the issue by Mr, Wiley, of a portion of the first volume of Miller's Chemistry, viz: that treating of Magnetism and Electricity. We are now glad to announce the appearance of the volume complete. It is considerably enlarged above the first and second edition, both by including matter formerly contained in the second volume and by important additions made necessary from the progress of science. The subjects of Dialysis, Spectral Lines, Specific Heat and Diathermancy of Gases and Vapors, and Heat of Combination, are fully discussed with reference to the most recent investigations. From its fullness, systematic arrangement and lucid style, this volume deserves the warmest praise, and commends itself equally as a text book and work of reference. We look for the speedy completion of the other volumes.

9. *Manual of Qualitative Chemical Analysis;* by Dr. C. R. Fresenius; from the last English and German editions, edited by Prof. Samuel W. Johnson of Yale College. 8vo, pp. 434. John Wiley, New York, 1864.—The new edition of this excellent manual fills a want which has long been felt by chemists; for, in addition to the matter found in the earlier editions, it contains the properties of all the *rarer elements*, and includes a full account of *spectral analysis*, *dialysis*, and the *reactions of the alkaloids*. Prof. Johnson has substituted the accurate and plain spectrum-plate, recently published by Kirchhof and Bunsen, in place of the incomplete and erroneous colored spectrum-plate contained in the foreign editions, and has also added numerous notes, making the work complete to the date of publication. The value of this text-book is too well recognized to be enlarged upon here; it has already passed through eleven German, and five English editions.

10. *On the Nature of Heat-vibrations;* by Mr. James Croll.—In a most interesting paper on Radiant Heat, by Professor Tyndall, read before the Royal Society in March last, it is shown conclusively that the *period* of heat-vibrations is not affected by the state of aggregation of the molecules of the heated body; that is to say, whether the substance be in the gaseous, the liquid, or perhaps the solid condition, the tendency of its molecules to vibrate according to a given period remains unchanged. The force of cohesion binding the molecules together exercises no effect on the rapidity of vibration.

I had arrived at the same conclusion from theoretical considerations several years ago, and had also deduced some further conclusions regarding the nature of heat-vibrations, which seem to be in a measure confirmed by the experimental results of Prof. Tyndall. One of these conclusions was, that the heat-vibration does not consist in a motion of an aggregate mass of molecules, but in a motion of the individual molecules themselves. Each molecule, or rather we should say each atom, acts as if there were no other in existence but itself. Whether the atom stands by itself as in the gaseous state, or is bound to other atoms as in the liquid or the solid state, it behaves in exactly the same manner. The deeper question then suggested itself, viz.: what is the nature of that mysterious motion assumed by the atom called heat? Does it consist in excursions across centres of equilibrium external to the atom itself? It is the generally received opinion among physicists that it does. But we think that the experimental results arrived at by Prof. Tyndall, as well as some others which will presently be noticed, are entirely hostile to such an opinion. The relation of an atom to its centre of equilibrium depends entirely on the state of aggregation. Now if heat-vibrations consist in excursions to and fro across these centres, then the *period* ought to be affected by the state of aggregation. The higher the *tension* of the atom in regard to the centre, the more rapid ought its movement to be. This is the case in regard to the vibrations constituting sound. The harder a body becomes, or, in other words, the more firmly its molecules are bound together, the higher is the *pitch*. Two harp-cords struck with equal force will vibrate with equal force, however much they may differ in the rapidity of their vibrations. The *vis viva* of vibration depends upon the force of the stroke; but the rapidity depends, not on the stroke, but upon the tension of the cord.

That heat-vibrations do not consist in excursions of the molecules or atoms across centres of equilibrium follows also, as a necessary consequence from the fact, that the real specific heat of a body remains unchanged under all conditions. All changes in the specific heat of a body are due to differences in the amount of heat consumed in molecular work against cohesion or other forces binding the molecules together. Or, in other words, to produce in a body no other effect than a given rise of temperature requires the same amount of force, whatever may be the physical condition of the body. Whether the body be in the solid, the fluid, or the gaseous condition, the same rise of temperature always indicates the same quantity of force consumed in the simple production of the rise. Now if heat-vibrations consist in excursions of the atom to and fro across a centre of equilibrium *external to itself*, as is generally supposed, then the *real* specific heat of a solid body, for example, *ought to decrease with the hardness of the body*, because an increase in the strength of the force binding the molecules together would in such a case tend to favor the rise in the rapidity of the vibrations.

These conclusions not only afford us an insight into the hidden nature of heat-vibrations, but they also appear to cast some light on the physical constitution of the atom itself. They seem to lead to the conclusion that the ultimate atom itself is *essentially elastic*. For if heat-vibrations do not consist in excursions of the atom, then it must consist in alternate

expansions and contractions of the atom itself. This again is opposed to the ordinary idea that the atom is essentially solid and impenetrable. But it favors the modern idea, that matter consists of a force of resistance acting from a centre.—*Phil. Mag.*, [4], xxvii, 346, May, 1864.

11. *On Periodic Changes in the Magnetic Condition of the Earth, and in the Distribution of Temperature on its Surface;* by Mr. BAXENDELL, F.R.A.S.—Considerations arising out of an investigation of the irregularities which take place in the changes of some of the variable stars led the author, some time ago, to regard it as highly probable that the light of the sun, and also its magnetic and heating powers, might be subject to changes of a more complicated nature than has hitherto been supposed, and that, besides the changes which are indicated by the greater or less frequency of solar spots, other changes of a minor character, and occurring in shorter periods, might also take place. In the hope of detecting these supposed changes, the author resolved to undertake the discussion of a series of magnetical observations, and for this purpose he selected the observations made at the Imperial Observatory of St. Petersburg, the most northern station at which hourly magnetic observations have been made for any lengthened period. Commencing, therefore, with the year 1848, the greatest and least values of the magnetic declination for every day were extracted from the observations, and taking the differences and arranging them in order, it was found, on a careful examination, that they indicated changes of activity taking place in a period of 31 days. The daily oscillations were then arranged in a table of 31 columns, and taking the means of the numbers in these columns, their differences from the general mean for the year were found to be as follows, the unit of value being one division of the scale of the magnetometer, or 26·3″ of arc:

	Diff. from general mean.		Diff. from general mean.		Diff. from general mean.		Diff. from general mean.
Day.	pts.	Day.	pts.	Day.	pts.	Day.	pts.
1	− 8·18	9	− 7·86	17	+ 0·49	25	− 1·11
2	− 8·25	10	− 7·99	18	+ 6·35	26	− 2·38
3	− 3·32	11	− 0·70	19	− 3·05	27	− 1·43
4	+ 1·18	12	+ 7·45	20	+ 2·65	28	+ 8·41
5	− 4·80	13	+ 14·83	21	+ 4·21	29	− 6 51
6	− 0·21	14	+ 9·22	22	+ 5·80	30	− 6·51
7	− 1·52	15	+ 1·19	23	+ 3·39	31	− 5·69
8	− 6·66	16	+ 5·99	24	+ 5·08		

A projection of these numbers shows that, of the *seventeen* consecutive days, 12 to 28, the amount of oscillation, or range of the magnetic needle, was *above* the mean value on *thirteen* days, and *below* the mean on only *four* days; while of the remaining *fourteen* days the range was *below* the mean on *thirteen* days, and above on *one* day only. The total amount of the differences for the seventeen days of maximum was 67·09, or 3·95 per day, and for the fourteen days of minimum it was 67·02, or 4·78 per day, the mean for the year being 39·86. The ratios of the average excess of a day of maximum, and of the average deficiency of a day of minimum, to the mean value, are therefore as 1 to 10·09, and as 1 to 8·34.

On proceeding to examine the observations for the succeeding years it was found that they could not be represented by a period of 31 days. It appeared, therefore, at first sight, that the period which had been obtained for 1848 was merely accidental; but, guided partly by conclusions drawn from his variable-star investigations, and partly by the high degree of improbability that the results for 1848 could be due to mere accident, the author was led to think that the period he had found for 1848 might be variable, gradually diminishing for a series of years, and afterward gradually increasing, to diminish again when it had completed its cycle of change. Assuming, therefore, that in every year periodic changes took place in the magnetic activity of the sun, the author proceeded to determine for each year the most probable approximate value of the period, and he obtained a series of values gradually diminishing till 1856, when the period was only about 23 days, and afterward rapidly increasing, until, in 1859, it amounted to about 32 days. A glance at these results at once suggested the idea that the variable period thus found was in some way connected with, and dependent upon, the great solar-spot period, the minimum value occurring in the year of minimum frequency of the solar spots, and the maximum values in the years when the spots were most numerous.

Several series of thermometrical observations were now examined for indications of periodical changes in the element of mean daily temperature, and it was found that they exhibited, with unexpected distinctness, changes in this element occurring also in a variable period, the range of variation being, however, somewhat less than in the case of the magnetic element, although the times of maximum and minimum were almost exactly the same. The maximum and minimum values were respectively 31 and 23½ days.

A table is given showing the number of days included in maximum and the minimum portions of each mean period for the years 1848 to 1859, and the number of exceptional days, or those on which during the maximum part of the period the temperature was *below*, and during the minimum part *above*, the mean value. From this table it appears that out of a total number of 165 days of maximum, only 14 were exceptional; and out of a total of 164½ days of minimum, the number of exceptional days was only 16. The mean gives a ratio almost exactly as 1 to 11. Considering that the values of the period in the different years are only approximate, this result may be regarded as affording satisfactory proof of the existence of a variable period of temperature; but a comparison of the total amount of the differences of temperature from the mean and the amount of exceptional differences which is given in another table is much more striking and conclusive. From this comparison it appears that, against a total amount of 255·61° of *plus* differences on maximum days, there were only 8·17° of *minus* differences; and against 258·61° of *minus* differences on minimum days, there were only 11·79° of *plus* differences, the mean ratio of the amount of exceptional differences to the total amount being therefore as 1 to 25·7.

At St. Petersburg the average temperature of the warmer half of the period is not less than 3° greater than that of the cooler half; and as this difference of temperature is repeated at least twelve times in every year,

it must necessarily exercise a powerful modifying influence over many meteorological phenomena.

With reference to the differences between the maximum and minimum values of the magnetic and the corresponding values of the temperature period, it is remarked that, owing to occasional interruptions of the magnetical observations and to the enormous extent of the oscillations of the needle on particular days, the values of the magnetic period given in the paper may require some correction; still it is believed that the ranges of the two periods are not identical.

Another period of change having a mean duration of rather over eighteen months is then referred to. The author was first led to it from a discussion of the Greenwich magnetical observations for the years 1848 to 1859; and it has been confirmed by the results of a discussion of temperature observations made at Brussels in Europe, and at Yakoutsk in Asia. It is obvious that this period will at times interfere sensibly with the shorter one, and it is probable that some of the cases which have been called exceptional may be due to this interference.

As it may perhaps excite surprise that in this investigation no use has been made of the fine series of observations taken at the British Colonial Observatories, it is remarked that a little consideration will serve to show that in the early stages, at least, of an inquiry like the present, little or no reliance could be placed on results derived from series of observations in which every seventh day, or fifty-two days in the year, were complete blanks. It has, in fact, been found that the omission of a single day in a year will in some cases produce a very sensible effect upon the final results for the magnetic period. Hence it is that the author regards some of the values he has obtained for this period as being open to correction when he may have an opportunity of discussing more complete sets of observations. Gen. Sabine, in his very elaborate discussions of the magnetical observations made at the colonial observatories, separates the larger movements of the needle from the general mass, and treats them as extraordinary disturbances, assuming apparently that the two classes of ordinary and extraordinary disturbances are due to different causes. The author has, however, not ventured to adopt this mode of proceeding, but has preferred to regard all the movements of the magnet, whether large or small, as having a common origin, and his discovery of the temperature period, by acting upon this view, may be regarded as affording strong evidence in its favor.

With regard to the probable cause of the variability of the short period, the author remarks that the subject is one of great difficulty; for, while the facts seem clearly to belong to the domain of astronomical science, he has found it impossible to frame any hypothesis to account for them without calling in the aid of some principle which has not hitherto been applied to the explanation of astronomical phenomena. It is therefore not without any considerable hesitation that he ventures to observe that the facts would perhaps be best explained by supposing—

1st. That a ring of nebulous matter exists differing in density or constitution in different parts, or several masses of such matter forming a discontinuous ring, circulating round the sun in a plane nearly coincident with the plane of the ecliptic, and at a mean distance from the sun of about one-sixth of the radius of the earth's orbit.

2d. That the attractive force of the sun on the matter of this ring is alternately increased and diminished by the operation of the forces which produce the solar spots, being greatest at the times of minimum solar-spot frequency, and least when the spots are most numerous.

3d. The attractive force being variable, the dimensions of the ring and its period of revolution round the sun will also vary, their maximum and minimum values occurring respectively at the times of maximum and minimum solar-spot frequency.

In reference to the nature of the varying attractive force, it is not improbable that the matter of the supposed ring may be highly diamagnetic, and being much nearer to the sun than any of the known planets, of much greater bulk and lightness, and being subjected to a much higher temperature, it will be very sensibly affected by the changes which take place in the magnetic condition of the sun; and when interposed between the earth and the sun, it may act not only by reflecting and absorbing a portion of the light and heat which would otherwise reach the earth, but also by altering the direction of the lines of magnetic force. The changes of temperature at the surface of the earth will thus be due partly to differences in the amount of heat received from the sun, and partly to changes in the movements of the great currents of the air produced by alterations in the earth's magnetic condition. If the larger part of the difference of temperature is due to the latter mode of action, we might expect that during the warmer half of the period the mean direction of the wind at any given station would be sensibly different from that during the cooler half; and also, that the epochs of maximum and minimum temperature would not be the same at all parts of the earth's surface. Both of these conclusions are borne out by the results given in the paper. Thus at St. Petersburg, in 1859, the mean direction of the wind on maximum days was S. 54° W., and on minimum days S. 73° W. or 19° more to the west of South; and at Sitka, on the northwest coast of North America, in 1851, the mean direction on maximum days was S. 32° W., and on minimum days S. 56° W., the difference being 24°. As striking instances of the differences in the epochs at distant stations, it may be stated, that in 1859 the epoch of maximum at St. Petersburg corresponded precisely with the epoch of minimum at Madras; and that at Pekin, in 1851, the epoch of minimum was exactly coincident with the epoch of maximum at Sitka.

Changes in the amount of heat received from the sun, sufficient to produce the variations of temperature observed at any given station, would no doubt affect the movements of the great currents of the atmosphere, though not to the extent indicated by the observations; but it is difficult to conceive that they could produce the differences in the epochs which are found to take place. We may therefore fairly conclude that the action of the supposed ring of nebulous matter is principally of a magnetic, and but slightly of a thermal character.

It is suggested that the greater range of variation of the magnetic, as compared with the temperature period, may be due to the inertia and elasticity of the great currents of air, the inertia tending to lengthen the temperature period, and the elasticity to shorten it; but as the inertia will act with greatest effect when the magnetic period is at its minimum,

while on the other hand the elasticity will be most effective when this period is at its maximum, the result will be a range of variation of the temperature period somewhat less than that of the magnetic.

Adopting, for the present, the maximum and minimum values of the temperature period as being determined with greater accuracy than those of the magnetic period, the greatest and least values of the sidereal period of revolution of the ring will be 29·12 and 22·08 days respectively. From these numbers we find that the greatest distance of the ring from the sun is 0·185, the radius of the earth's orbit being taken as unity; the least distance, 0·154; and the mean 0·169. Taking Mr. Hind's value of the mean distance of the earth from the sun, namely, 91,328,600 miles, we have:

Greatest distance of the ring	=	16,921,000	miles.
Least " "	=	14,068,000	"
Mean " "	=	15,494,500	"

and the range of movement to and fro in a radial direction = 2,853,000 miles. The greatest attractive force of the sun on the ring being taken as unity, the least will be 0·691. The difference is therefore nearly one-third of the maximum amount. It will be evident that this difference may be regarded as a measure of the forces which are concerned in the production of the solar spots.

The results of the elaborate investigations of the motions of the planet Mercury, made by Leverrier, led that accomplished mathematician to attribute a certain unexplained excess in the motion of its perihelion to the action of a disturbing body circulating round the sun within the orbit of Mercury; and, from a discussion of the probable mass of the disturbing body, he concluded that it could not be concentrated in a single planet, and that it consisted of a ring of small bodies similar to that which is known to exist between the orbits of Mars and Jupiter; and it is remarkable that the mean distance, which he seemed to regard as the most probable, is precisely that which the author has found for the ring of nebulous matter, whose existence he has assumed to account for the phenomena described in his paper. This unexpected and unlooked-for agreement between results arrived at from considerations and by methods so totally different, seems to establish the existence of this ring with quite as much certainty, as the results of the profound researches of Adams and Leverrier established the existence of Neptune before that planet had been actually seen. This ring, however, owing to its proximity to the sun, may never be seen, and, like the dark companions of Procyon and Sirius, it may only be known to us through its action on the other bodies of the system of which it forms a part. Should future researches place its existence beyond doubt, this will, it is believed, be the first instance in which the conclusions of physical astronomy have been confirmed by the results of an investigation of magnetical and meteorological phenomena. Whether, however, the hypothesis which the author has ventured to put forward be accepted or not, it is now very evident that observations of solar phenomena merit a much larger share of attention than has ever yet been devoted to them. It has long been suspected that the same causes which produce the spots on the sun's disc

must in some way have an important influence on the phenomena of our own atmosphere. The facts now given convert this suspicion into a certainty; and it is perhaps not too much to say that meteorology can never take rank as a true science while our knowledge of the sun remains in its present imperfect state. Moreover, there is little doubt that many questions of high physical interest depend for their solution upon our obtaining a more intimate acquaintance than we yet possess with the operations which are going on in the great centre of our system. It is therefore much to be desired that some of the many observatories which are now established in various parts of the world should be specially devoted to observations of the sun, and of solar phenomena generally; and that the principal magnetical and meteorological elements should be observed daily, without interruption, at all the regular magnetical and meteorological observatories.

It may be stated that the values of the variable-temperature period, given in this paper, were derived from observations made at St. Petersburg, Wardoe, Gorki, Barnaoul, Irkoutzk, Nertchinsk, Yakoutsk, Pekin, Madras, Novo-Petrovsk, Lougan, Zurich, Geneva, Milan, Brussels, Greenwich; Jakobshavn, in Greenland; and Sitka, on the northwest coast of North America. The comparison of the variable-temperature period with the solar-spot period extends over the twenty-seven years, 1833–59, and therefore includes three maxima and three minima of solar-spot frequency.—*Proceedings Manchester Lit. and Phil. Soc.*, March 8, 1864.

II. MINERALOGY AND GEOLOGY.

1. *Analyses of Swedish and Norwegian Minerals;* by J. A. Michaelson.—(1.) *Radiolite.*—Specimens of the radiolite occurring in the zirconsyenite at Brevig (Norway), and collected at the locality by the author, had a flesh-red color, a radiated structure, and but a feeble lustre. H.= 5. G.=2·22. In the closed tube gave water, and B.B. fused to a white opaline glass. Decomposed by acids. Composition:

Si̇	Al̈	Fe̊	Cå	Nå	K̊	Ḣ	
47·73	26·04	0·53	2·22	13·37	0·40	10·24	= 100·53

showing the mineral to be natrolite in which a small portion of the soda is replaced by lime.

(2.) *Schefferite: a supposed new variety of Pyroxene.*—Schefferite occurs at Langbanshytta. Color, reddish-brown. H.= 5·5. G.= 3·39. B.B. fuses slowly to a black glass. With borax and salt of phosphorus gives an amethystine bead in the outer flame, becoming colorless in the reducing flame; with salt of phosphorus leaves a skeleton of silica. Fused with soda yields a green bead. Treated with chlorhydric acid evolves chlorine, and effects a partial decomposition of the mineral. Composition:

	Si̇	Cå	Mg̊	Mn̊	Fe̊	F̈e	Ign.	
	52·31	19·09	10·86	10·46	1·63	3·97	·0·60	= 98·92
Oxygen,	27·19	5·42	4·34	2·35	0·37	1·19		
				13·67				

The oxygen ratio of silica to bases is 2 : 1, and the author places the mineral near Jeffersonite. It is associated with rhodonite, and heretofore

has been supposed by many mineralogists to be a variety of garnet. [Michaelson's analysis is interesting as proving the mineral to be a manganesian pyroxene, but the figures in regard to the relative amount, and state of oxydation of the iron and manganese are not trustworthy, for if the mineral evolves chlorine, on treatment with chlorhydric acid, it must contain one of the higher oxyds of manganese, although only protoxyd is mentioned in the analysis. Michaelson determined the amount of protoxyd of iron by titration after fusion of the mineral with borax, and subsequent solution of it in chlorhydric acid in the presence of an atmosphere of carbonic acid. But the solution of a mineral containing a higher oxyd of manganese with protoxyd of iron, necessarily oxydizes a portion of the iron, at the expense of the oxygen of the oxyd of manganese, even though the atmospheric air be excluded, consequently the amount of sesquioxyd of iron given in the analysis must be incorrect, and it is possible that the mineral contains no sesquioxyd of iron. It may be considered a slightly altered manganesian pyroxene, and it would seem, therefore, that the new name is superfluous.—G. J. B.]

(3.) *Hedyphane.*—Hedyphane, from Langbanshytta, has a grayish-white color, inclining slightly to yellow, is translucent, and has a greasy lustre, and uneven fracture. B.B. fuses easily to a white enamel, and on charcoal, gives an arsenical odor. H.=4. G.=5·46. Composition:

Cl	P	As	Pb	Ca
3·06	3·19	28·51	57·45	10·50
2·93	0·86			

This is equivalent to 11·70 PbCl, 2·02 P, 28·51 As, 48·13 Pb, 10·50 Ca, giving the formula $PbCl+3[(Pb,Ca)^3(As,P)]$.

(4.) *Orthite-like mineral from Aarö near Brevig.*—This dark-brown mineral is associated with melinophane. It has a vitreous lustre on the fracture, and in thin splinters is transparent to translucent. Hardness, between 3 and 4. G.=3·44. Not crystallized. Composition:

	Si	Ce	La, Di	Y	Be	Al	Zr	Fe	Ca	Mg	Na	H
1.	29·21	9·79	15·60	1·63	4·27	2·81	5·44	6·42	14·93	0·45	2·45	5·50
2.	28·80	11·47	14·12	1·49		17·51			16·06	*tr.*	—	—

Analyses 2 was by Nobel, who obtained also 0·83 (?) precipitated by sulphuretted hydrogen. The mineral was decomposed by chlorhydric acid. A portion of the iron existed as protoxyd, but the small quantity of the mineral operated upon would not permit its determination. The author considers that the mineral is nearly related to *Erdmannite.*—*Jour. prakt. Chem.*, xc, 106. G. J. B.

2. *Kokscharovite.*—Hermann has further investigated kokscharovite. The specimen examined was associated with lapis-lazuli and calcite, and after careful picking out, the coarse powder was separated from adhering calcite by dilute chlorhydric acid,

The mineral thus purified was in crystalline fragments of a dirty-white color, with a vitreous lustre, and was translucent on the edges. G.=2·97. In the closed tube, gave only traces of water. B.B., in the forceps, fused easily to a white translucent pearl, coloring the flame yellow; with borax, gave a clear colorless glass. Composition:

	Si	Al	Fe	Ca	Mg	K	Na	Ign.	
	45·99	18·20	2·40	12·78	16·45	1·06	1·53	0·60	= 99·01
Oxygen,	23·89	8·50	0·53	3·63	6·46	0·18	0·39		

The form of the mineral, as has already been stated in this Journal ([2], xxvi, 354), is that of hornblende; if the alumina is considered as replacing silica, the oxygen ratio of these to the bases is 2·98 to 1, differing very materially from all of the aluminous hornblendes and pyroxenes investigated by Rammelsberg, and requiring a portion of alumina to be basic in order to be included under the general formula $(\dot{R}^3\dot{R})\ddot{S}i^2$.—*Jour. prakt. Chem.*, lxxxviii, 197. G. J. B.

3. *Samarskite.*—FINKENER has found that samarskite contains zirconia and thorina, both of these substances having been overlooked by previous analysts. Analysis gave 4·35 pr. ct. zirconia and 6·05 thorina. —*H. Rose in Ber. Preuss. Akad.*, Nov., 1862. G. J. B.

4. *Kupfferite.*—Kupfferite is from a graphite mine in the Tunkinsk Mountains, and was named by Kokscharow in honor of the eminent physicist Kupffer. It has the form of actinolite, and is remarkable from its containing oxyd of chromium. A similar mineral has been obtained by Hermann from the Ilmen Mountains; it occurs in granite, forming an aggregate of prismatic crystals, the planes of which have an angle of 124° 15′. Cleavage prismatic. Color of the crystals emerald-green when fresh, but on exposure weathering to a brownish color. In thin splinters, translucent. Lustre, vitreous. H.=5·5. G.=3·08. In the closed tube, gives traces of water, but is otherwise unchanged. B.B., in the forceps, becomes opaque and white, but is infusible. Dissolves in borax, giving a chrome-green glass. Composition:

	$\ddot{S}i$	$\ddot{C}r$	$\dot{N}i$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}, \dot{N}a$	Ign.
	57·46	1·21	0·65	6·05	2·94	30·88	*tr.*	0·81=100·00
Oxygen,	29·85	0·38	0·14	1·34	0·83	12·03		

This gives the oxygen ratio of bases to silica 1 : 2·02, which is almost precisely that of pyroxene, while the form is like hornblende. Hermann considers that the presence of oxyd of chromium entitles the mineral to be considered a distinct species, and also calls attention to the large amount of magnesia, remarking that it may be looked upon as an *enstatite* with the form of hornblende.—*Jour. prakt. Chem.*, lxxxviii, 195. G. J. B.

5. *Planerite, a new mineral.*—HERMANN has described a new phosphate from Gumeschefsk in the Urals. It resembles wavellite in its mode of occurrence and also in composition. It is found lining clefts in a quartzite, forming a thin botryoidal coating. Color olive-green to verdigris-green, the darker color being due to superficial oxydation of the iron. Structure crypto-crystalline, the surface drusy, and on the fracture fibrous. Lustre dull, under the magnifier glistening. Streak greenish-white. H.=5. G.=2·65. In the closed tube, decrepitates and gives off much water. In borax fuses easily, giving reactions for copper. Acids attack the mineral only imperfectly, but it is easily dissolved on boiling with caustic soda, leaving a black residue consisting of the oxyds of copper and iron. Analysis gave:

	$\ddot{P}$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}u$	$\ddot{H}$	
	33·94	37·48	3·52	3·72	20·93	= 99·59
Oxygen,	19·02	17·50	0·78	0·75	18·60	

Hermann makes the formula $4(\ddot{A}l^2\ddot{P}^2+9\ddot{H})+3(\dot{C}u, \dot{F}e)\ddot{H}$.—*Jour. prakt. Chem.*, lxxxviii, 193. G. J. B.

6. *Forcherite.*—The name Forcherite has been given by AUHHORN to a yellow opal found in gneiss at Reittelfeld in Styria. An examination by R. L. Maly proved the mineral to be hydrated silicic acid colored yellow by sulphid of arsenic.—*Jour. pr. Chem.*, lxxxvi, 501.

7. *Garnet.*—PISANI has analyzed the octahedral garnet from Elba. It occurs associated with chlorite and yellow epidote in octahedral crystals, from two to five millimetres in diameter, of a honey-yellow color. Hardness, somewhat greater than quartz. B.B., fuses to a black enamel. In the spectroscope, shows lime, with traces of soda. Slowly decomposed by chlorhydric acid, but more rapidly when the mineral is previously ignited. Composition:

$\ddot{S}i$	$\ddot{A}l$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{M}n, \dot{N}a$	Ign.	
39·38	16·11	8·65	36·04	1·00	*traces.*	0·31	= 101·49

This is nearly the same composition as *grossular.*—*Compt. Rendus*, lv, 216; *Jour. pr. Chem.*, lxxxvii, 383.

8. *Native zinc.*—PHIPSON has described the occurrence of native zinc in a basalt from Brunswick near Melbourne in Australia. A specimen of this zinc was exhibited at the London Exhibition of 1862.—*Comptes Rendus*, lv, 218.

9. *Esmarkite.*—A so-called *esmarkite* from Norway, analyzed by PISANI, proves to be identical with scapolite. It would thus seem that this name has been applied to three minerals: (1) a variety of iolite, (2) to datholite, and (3) to scapolite. Pisani suggests the propriety of dropping the name altogether.—*Comptes Rendus*, lv, 450.

10. *Infusorial earth from Bohemia.*—R. HOFFMANN has analyzed the infusorial earth from Kutschlin near Bilin, and from Meistersdorf, and also the diatom deposit from near the Louisa-spring in Franzensbad. Analyses: 1. Upper layer, Bilin. 2. Lower layer, Bilin. 3. Meistersdorf. 4. Franzensbad.

	1.	2.	3.	4.
Ammonia,	0·03	0·01	0·34	
Potash,	0·02	0·30	0·24	0·40
Soda,	0·30	*tr.*	*tr.*	
Magnesia,	——	0·43	0·36	0·05
Lime,	0·41	0·44	0·64	*tr.*
Alumina, ferric oxyd,	6·81	5·40	5·60	0·91
Sulphuric acid,	0·12	*tr.*	0·54	——
Phosphoric acid,	0·24	*tr.*	*tr.*	0·19
Silica,	74·20	80·30	72·60	77·00
Organic matter,	4·20	1·30	13·20	15·45
Water,	13·30	10·90	7·00	6·00 (loss)
	99·63	99·08	100·52	100·00

No. 1 is the "tripoli" or polishing powder; it has a density of 1·862, absorbs water rapidly, taking up about $1\frac{1}{3}$ times its weight, and splits into thin plates. Density of No. 2 equal 1·944; it is harder than No. 1, and not used for polishing. None of these infusorial earths scratch glass. The total amount of nitrogen contained in No. 4 was 0·401 p. c.—*Jour. prakt. Chem.*, xc, 467. G. J. B.

11. *On a cavern with human remains in the Pyrenees;* by Messrs. F. GARRIGOU and L. MARTIN.—The cavern which has been explored recently by Messrs. Garrigou and Martin, is one called *Espélugues*, situated

in the commune of Lourdes, and the department of the Hautes Pyrénées. Two years since, it was visited by Alphonse Milne Edwards and Lartet, who published a detailed description in the Annales des Sciences Naturelles. Messrs. Garrigou and Martin add many interesting facts to those brought forward by these two earlier observers, from which we cite the following:—

"Within the cavern, toward the entrance of the great hall, there are great numbers of large blocks of limestone lying together upon a bed of rounded stones. Among these blocks, and especially at their base, are heaps of cinders and charcoal, some fragments of which occur at different places in the general deposit of the cavern. Bones, jaws, and teeth of different Mammals were obtained, especially from the lower part of the deposit. The surface layers of the deposit, which had been already turned up, afforded us only rare fragments, and these, before commencing our second day's examination, we carefully laid aside for separate study. Quantities of cut flints, bones, and horns of various stags, worked and shaped into the form of instruments and weapons, and some carved bones, lay in confusion along with the ashes and coal. Some of these remains were from the upper level of the deposit already worked.

We shall describe first the relics in the upper layer, explored before us by Milne Edwards, and then those of the lower strata, now examined by us.

(1.) *Upper layer.*—We cannot do better, in giving the list of the Mammals found in the upper portion of the deposit, than to repeat what has been written by Alphonse Milne Edwards. He found remains of the Fox, Horse, Wild Boar, Stag, Chamois, Wild Goat (Bouquetin), Reindeer, Aurochs, Ox, Mole, Field Mouse, and Birds. We add, to complete this list, a Goat smaller than the Bouquetin and larger than the Chamois, and a Sheep of the size of the Goat.

The bones of all these animals are broken like those of the Kjoekkenmodding of Denmark, of the lake habitations of Switzerland, and of the caverns, of the age of stone, of Ariège.

Among these paleontological fragments, some, on careful examination, led us to infer that the domestication of certain animals had been in practice during the period under consideration.

Among the broken bones of the surface, some had evidently been attacked by Rodents. Near by were others bearing marks of the teeth of a Carnivore (a dog, beyond doubt).

Among the debris that we have ourselves examined, we collected, twenty centimetres below the surface, a small fragment of a rib of a Ruminant bearing a sculptured design of fine finish, and differing in this respect from objects of the same kind found at Bruniquel and in the caves of Périgord. The sculpturing is a portion of a larger design whose signification we can not give. An antenna of an insect, however, seems to be represented by one of the principal markings in the drawing.

We will conclude what we have to say of the upper part of the cavern deposit (a complete description of which is given by Alph. Milne Edwards), by saying that the specimens collected in this part seem more fresh, less altered, and less colored than those of the lower layers. This last fact has strongly impressed the minds of those to whom we have shown the results of our excavations.

(2.) *Lower layers.*—The list of animals found in the lower beds of the cavern differs a little from the preceding. We notice the Horse, the common Stag, the Reindeer, the Aurochs, an Ox smaller than the Aurochs but larger than that found in the upper beds, the Bouquetin, a large Sheep, two Rodents, and some bones of birds. The teeth of the Horse are more abundant than those of the Ox or Reindeer, but the bones of the Reindeer are more numerous than those of other Ruminants.

All these bones are broken like those which are found in caves inhabited by man; the heads of the bones alone are entire.

While the bones of the surface are grayish white externally, those of the lower part of the deposit are colored red, as at Bruniquel, Lyzies, May-d'Azil, and Izeste. The former do not adhere to the tongue, and evidently contain gelatine, while the latter adhere to the tongue and contain no gelatine. In order to be sure as to the gelatine, we burned two fragments of bone on live charcoal; that taken from the surface afforded almost immediately an insupportable empyreumatic odor, and the other, taken from below, no odor at all.

Throughout the extent of the bed examined by us, even to the rolled pebbles at the surface, there are found, along with the bones, wrought flints, and also instruments and tools made of the horns of the Reindeer and common Stag, and of bone. More than four hundred flints, most of them wrought, and coarsely so, were turned out. These may be classified as follows:

(1) Knives; (2) scrapers; (3) arrow heads roughly hewn, and sometimes having the lower extremity long for attachment to a handle; (4) wrought hatchets of small size, but of the same form with those from the diluvium of Abbeville and Amiens; (5) fragments of flint which were chipped from the instruments here described.

More than twenty-four objects of stag horn, of reindeer horn and of wrought bones, and also one bone very coarsely sculptured, rewarded our excavations in the lower beds. The sculptured bone represents, as nearly as we can judge, a fish with ventral fins and a divided tail. The skill of the artist was inferior to that in the case before mentioned.

The wrought objects may be divided into two categories: those coarsely wrought, and those of more finish. The collection of objects is very closely like that of the grotto of Izeste (Basses Pyrénées).

It appears evident to us that the inhabitants contemporary with the inferior deposits of Lourdes, and those of the cavern of Izeste, had a degree of civilization nearly equal to, and yet a little below, that of the occupants of the caverns of Périgord, Bruniquel, etc.

From a review of the facts, it is plain that the age of the upper layers of the deposit in the cavern of Lourdes is not the same as that of the lower.

Our examination of the bones collected by us from the upper beds, leads to the same result that has been announced by Alph. Milne Edwards, after his investigations with Mr. Lartet. We conclude from the presence of the Aurochs, the existence of domestic animals, the discovery of bones gnawed by dogs, the almost complete preservation of the gelatine in the bones and their deeper color, and by the discovery of a bone finely sculptured, that the upper beds belong to an age more recent than that of the lower beds. This we would call, as done by Messrs.

Edwards and Lartet, the age of the Aurochs, with which Man was contemporary.

As to the lower beds, it is evident to us, from the abundant remains of the Reindeer, including large quantities of its horns; from the coarseness of its wrought objects, its worked flints and its sculpture; from the reddish brown color of the bones, and from the absence of gelatine and their adhering to the tongue, that they pertain to an epoch more ancient than the preceding. It was the age of the Reindeer, parallel with that which we have distinguished in describing the grotto of Izeste.

The cave of Lourdes has thus afforded the first example of the direct superposition of the beds of the two consecutive paleontological epochs of the Quaternary or Post-tertiary period—such as they have been indicated by our learned and venerated master, Mr. Lartet."—*L'Institut, May* 11.

12. *On further discoveries of Flint Implements and Fossil Mammalia;* by J. Wyatt, Esq., F.G.S.—The opening of a section at Summerhouse Hill gave the author an opportunity of ascertaining whether the gravels at that lower level exhibited any features different from those of the upper level at Biddenham. Although, as might have been expected, some of the species of mammals were found to be common to the two localities, yet that under notice furnished some species of mammals, as well as of land and freshwater shells, together with a few types of flint implements, differing from those met with at higher levels.

Mr. Wyatt described the section at Summerhouse Hill in detail, showing that it tended to support Mr. Prestwich's opinions respecting the formation of gravel beds; he also described the Flint Implements he had recently found, comparing them with known specimens from the Valley of the Somme and elsewhere; and he stated that he was now enabled to add two new localities near Bedford—Summerhouse Hill and Honey Hill —to those already known as having furnished similar weapons.—*Phil. Mag.*, [4], xxvii, 544.

13. *On some recent discoveries of Flint Implements in Drift Deposits in Hants and Wilts;* by John Evans, Esq., F.G.S., etc.—Flint implements having recently been found on the sea-shore about midway between Southampton and Gosport, by Mr. James Brown of Salisbury, and also at Fisherton, near Salisbury, by Dr. H. P. Blackmore of that place, the author visited these localities in company with Mr. Prestwich, and gave the results of his observations in this paper.

After describing the implements from near Southampton, and having shown that their condition is identical with that of the materials composing the gravel capping the adjacent cliff, Mr. Evans proceeded to review the evidence of the great antiquity of these remains, which rested mainly on the circumstance that these gravel-beds, like those of Reculver, are of fluviatile origin, although now abutting on the sea.

In like manner the author then described the Fisherton implements, and the gravel-pits from which they were obtained. The relation of the high-level gravels (in which the implements were found) to the lower-level gravels of the valley of the Avon was next discussed, and the geological features of the former deposits particularly described, lists of the fossils (including the Mammalia and the Land and Freshwater Shells)

being also given. Mr. Evans came to the conclusion that the fossils bore evidence that the climate, at the time when they were deposited, was more rigorous, at any rate in the winter, than it now is; and to this cause he attributed the comparatively greater excavating power of the early Post-pliocene rivers.—*Phil. Mag.*, [4], xxvii, 544.

14. *Lake-dwellings or Pfahlbauten in Bavaria.*—Ancient lake-dwellings, in general like those of Switzerland, have been discovered in Bavaria in the Sternberg Lake.

15. *On some Bone- and Cave-deposits of the Reindeer-period in the south of France;* by Mr. JOHN EVANS, F.R.S.—The deposits to which the author particularly called attention in this paper are those which have been, and are still being, explored under the direction of Mr. Lartet and Mr. Christy, and which were visited by him under the guidance of the latter gentleman, and accompanied by Mr. Hamilton, Professor Rupert Jones, Captain Galton, Mr. Lubbock and Mr. Franks. Mr. Evans first gave a detailed description of the physical features of the valley of the Vézère, and of the contents of the caverns of Badegoule, Le Moustier, La Madeleine, Laugerie-Haute, Laugerie-Basse, the Gorge d'Enfer, and Les Eyzies, giving a list of the animal remains discovered, which are, for the most part, of the same species from all the caverns. The author then discussed the antiquity of the deposits according to four methods of inquiry—namely, from geological considerations with regard to the character and position of the caves, from the paleontological evidence of the remains found in them, from the archeological character of the objects of human workmanship, and from a comparison with similar deposits in neighboring districts in France; and he came to the conclusion that they belonged to a period subsequent to that of the *Elephas primigenius* and *Rhinoceros tichorhinus*, but characterized by the presence of the reindeer and some other animals now extinct in that part of Europe.—*Proc. Geol. Soc.*, in *The Reader*, July 2.

16. *On the Cavern of Bruniquel, and the Human Remains found therein;* by Professor OWEN.—Professor Owen minutely details the circumstances under which these discoveries were made; and states that the contemporaneity of the human remains with those of the extinct and other animals with which they are associated together with the flint and bone implements is shown by the evidences of the plastic condition of the calcified mud of the breccia at the time of interment, by the chemical constitution of the human bones, corresponding with that of the other animal remains, and by the similarity of their position and relations in the surrounding breccia.

Among the principal remains of the men of the flint period described are the following: (1) The hinder portion of the cranium, with several other parts of the same skeleton, which were so situated in their matrix as to indicate that the body had been interred in a crouching posture, and that, after decomposition and dissolution of the soft parts, the skeleton had yielded to the superincumbent weight; (2) an almost entire calvarium, which is described and compared with different types of the human skull, which Professor Owen shows to be superior in form and capacity to the Australian type, and more closely to correspond with the Celtic type, though proportionally shorter than the modern Celtic and

the form exhibited by the Celtic cranium from Engis, Switzerland; (3) jaws and teeth of individuals of different ages.

After noticing other smaller portions of human crania, the lower jaw and teeth of an adult, the upper and lower jaws of immature individuals are described, the characters of certain deciduous teeth being referred to. The proportions of the molars are not those of the Australian, but of other races, and especially those of ancient and modern Europeans. As in most primitive or early races in which mastication was little helped by arts of cookery, or by various and refined kinds of food, the crowns of the molars, especially of *m* 1, are worn down, beyond the enamel, flat and smooth to the stumps, exposing there a central tract of osteodentine without any signs of decay.

The paper was illustrated by a view and plans of the cavern, and by figures of the principal human remains, and of two implements of bone on which the Viscomte de Lastic had discovered, on removal of the breccia, outline figures of the head of a reindeer and the head of a horse in profile.—*Proc. Roy. Soc.*, in *The Reader*, June 18.

17. *On Human remains in Caves at Gibraltar;* by Geo. Busk. (Letter addressed to the Editors of "The Reader," and dated 15 Harley street, July 16, 1864.)—On the 30th of January last you afforded me an opportunity of stating the circumstance of the discovery by Capt. Brome, Governor of the Military Prison at Gibraltar, of a cavern, or rather a series of caverns and fissures, on Windmill Hill in that place. I also stated that Captain Brome had forwarded, some time before, a very large and valuable collection of various animal and human remains, which were in course of examination by Dr. Falconer and myself. Since then, we have received from the same gentleman a second very large consignment of similar remains from the same locality, and which, like the former, were packed, arranged, and ticketed with the greatest care and discrimination. Still more recently, Captain Sayer (the author of the latest History of Gibraltar) has brought over for us some human and other remains from a different place, about 200 feet lower down than the Windmill Hill Flats. These remains, as we understand from Captain Sayer, were procured some years since by Sir James Cochrane from a very deep and till then unexplored cavern, the entrance of which is in his own garden. And again, within the last few days, we have been furnished with additional human and other bones from Captain Brome; but we are as yet uninformed as to the precise locality whence these have been derived. We have also received from Mr. Mawe two portions of bone-breccia containing a considerable number of fragments, amongst which the most important is a large portion of the plastron of a species of tortoise. Captain Douglas Galton has also communicated to us two large fragments of ossiferous breccia procured from Camp Bay, close to Rosia Bay.

In my former communication I gave a rough list of the chief animals whose bones were contained in the first collection sent by Captain Brome, and referred to some great peculiarities observable in many of the human bones. The second collection forwarded by the same gentleman, although it has not added many new species to those contained in the former, has yet been of inestimable value from the additional means it has afforded

us for the proper identification of many of the species. The human remains contained in the second collection were, as in the previous one, very numerous, but, unfortunately, in an equally fragmentary condition, especially as regards the crania. In the two collections we have nearly 400 fragments of skulls, most of the fragments very small, and nearly all presenting signs of very ancient fracture. Out of this enormous mass I have as yet succeeded in building up no more than about half of the cranium of one individual and smaller portions of three or four others. But the larger specimen thus constructed suffices in some measure to give an idea of the general contour and size, &c., of the skull when entire; and, taken in conjunction with the numerous more or less perfect frontal and lower jaw-bones, this cranium and the other less complete specimens afford an insight into the cranial conformation of some of the human beings then existing on the Rock of Gibraltar. One conclusion that we were inclined to adopt, as I stated before, was that the lower jaws, at any rate, might be referred to two distinct types. This opinion appeared to be strengthened also by the circumstance that some of the other bones of the skeleton presented very remarkable distinctive characters. Among the numerous leg and thigh bones, belonging, as near as I can estimate, to 35 or 36 individuals, are many so singular and, as it may almost be said, so monstrous in their form as to have excited the astonishment of all anatomists who have beheld them. Notwithstanding diligent search and inquiry, we have as yet been unable to meet with, or hear of, any similar bones in collections in this country, although in Paris, through the great kindness of Messrs. Pruner-Bey and Lartet, Dr. Falconer, on a late visit to that city, was put in possession, for the purpose of comparison, of some from Algeria and one from Laugerie, in the valley of the Vézère, approaching the same type.

Under these circumstances, any further contributions to our anthropological materials from Gibraltar became of the utmost importance to us. The human cranium brought by Captain Sayer from the lower, or Sir James Cochrane's, cave was a welcome addition of this kind. It is fortunately quite perfect, except that the lower jaw properly belonging to it has been replaced by one of a different individual, and we are consequently unable to determine the character of that highly important bone. The skull itself, as were most of the bones with which it was accompanied, was encased in a very hard gray stalagmitic crust, in some parts several inches thick, and evidently the result of very long and slow deposition. But when this was removed, the bone stood out as fresh to all appearance as if it had been carefully macerated and cleaned. It is a small, roundish, symmetrical cranium; but we have not yet so critically compared it as to allow of any definite opinion being given on the present occasion as to its nearest probable affinities. In one respect it is of extreme interest, from its being associated with several leg bones presenting the peculiar compressed form above adverted to, and among which one, from the condition of the bone itself and the exact similarity of the calcareous incrustation upon it, most probably belongs to the same individual. We thus appear to be furnished with a clue to the cranial conformation of the "sharp-shinned" or *platycnemic* race—a point of considerable importance.

But by far the most important addition to the human remains from Gibraltar is contained in the last contribution just received from my friend Captain Brome. This collection includes, besides several quadrupedal bones, the greater part of a human cranium, and a lower jaw not belonging to it. The cranium resembles, in all essential particulars, including its great thickness, the far-famed Neanderthal skull; but, in many respects, it is of infinitely higher value than that much-disputed relic, inasmuch as it retains the entire occipital region, including the hinder margin of the foramen magnum, great part of the base, the whole of one temporal bone (thus giving the precise situation of the auditory opening), and nearly the entire face, including the upper jaw, with most of the much and curiously-worn teeth. As it is precisely these parts that are wanting in the Neanderthal calvarium, of which the present is, in other respects, almost an exact counterpart, the value of this cranium in the study of priscan man can not be rated too high. Its discovery also adds immensely to the scientific value of the Neanderthal specimen, if only as showing that the latter does not represent, as many have hitherto supposed, a mere individual peculiarity, but that it may have been characteristic of a race extending from the Rhine to the Pillars of Hercules; for, whatever may have been the case on the banks of the Düssel, even Professor Mayer will hardly suppose that a rickety Cossack engaged in the campaign of 1814 had crept into a sealed fissure in the Rock of Gibraltar.

As this cranium will shortly, I hope, be fully described and figured, I will not now enter into any further particulars concerning it, more than simply to remark that, in several respects, owing perhaps to its greater completeness, it presents more strongly marked pithecoid characters than even the Neanderthal calvarium possesses, and that, from the mineral condition of the bone itself, apart from its intrinsic characters of form, there can be no doubt of its enormous antiquity. The other bones also sent with it, and obviously taken from the same locality, though not themselves of an extinct species, yet belong to one (*Ibex*) whose remains occur very abundantly throughout the Rock in the oldest breccia, in which are also contained those of at least one, if not of two, wholly extinct species of Rhinoceros, and of several other animals which are extinct, so far as Europe is concerned.—*The Reader*, July 23.

18. *On the Rhætic Beds and White Lias of Western and Central Somerset, and on the Discovery of a new Fossil Mammal in the gray Marlstones beneath the Bone-bed;* by Mr. W. Boyd Dawkins.—After describing the sections in the district, and showing the paleontological relations of the White Lias to the *Avicula contorta* series and the zone of *Ammonites planorbis*, the author enunciated the following conclusions: (1) That the true position of the White Lias is immediately above the *Avicula contorta* zone of Dr. Wright, and at the base of the Lower Lias shales; (2) that it is entirely distinct from the Rhætic beds, lithologically and paleontologically; and (3) from the discovery of Rhætic fossils in the Gray Marls below the Bone-bed, that the latter belong to the Rhætic formation. He then proceeded to describe a two-fanged mammalian tooth which he had found in the Gray Marlstones below the Bone-bed, and which he considered to be the analogue of the trenchant four-ridged

premolar of *Hypsiprymnus* of the section to which *H. Hunteri* belongs. Until additional remains be found, its affinities to *Microlestes* or *Plagiaulax* can not be determined; Mr. Dawkins has, therefore, named it provisionally *Hypsiprymnopsis Rhæticus*. In conclusion, he traced the range of the Marsupials in space and time, showing that, of the six families into which Van der Hoeven divides the existing Marsupials, two—the entomophagous and sarcophagous *Dasyrurina*, and the phytophagous *Macropoda*—had been represented in England during the interval between the deposition of the Purbeck beds and that of the Rhætic Marlstones below the Bone-bed.—*Proc. Roy. Soc.*, in *The Reader*, June 18.

19. *Mesozoic Mammals.*—The announcement that Mr. Boyd Dawkins of the Geological Survey had discovered a tooth of a small mammal allied to the kangaroo in the Rhætic beds of Watchet has attracted during the past fortnight much attention among paleontologists. At the Geological Society, where the description of the specimen was read, the greatest possible interest was excited; and, although there may be a doubt as to the precise family of Marsupials to which the new *Hypsiprymnopsis Rhæticus* Dawkins, can be referred—whether, in point of fact, it may not be nearer allied to the *Microlestes* of Plieninger (best known to Englishmen through the researches of Mr. Charles Moore)—there can be no doubt whatever of the interest to be attached to the discovery now made. A retrospect of our present knowledge of Secondary Mammalia may now be interesting. The (Triassic) bone-beds of Würtemberg, and at Aust Cliff in Gloucestershire, afford us evidence of the diminutive *Microlestes;* in the N. Carolina coal-field we have Dr. Emmons's *Dromatherium sylvestre;* at Biegerloch was found the *Tristichodon* of Dr. Falconer, one of the most remarkable and aberrant forms, dissimilar in its characters of dentition to any known mammal, extinct or existing, unless possibly the slight analogy which the ternate division of its tooth-cusps bears to *Stereognathus* can be taken into account; *Stereognathus ooliticus* itself appears in the oolites; where also are to be found the *Amphitherium Prevostii*, the *Amphilestes Broderipis*, and the *Phascolotherium Bucklandi*, allied to the *Myrmecobii* of the existing Antipodes. Higher up in the Purbeck series the new Mammalia are so numerous that it would be premature to discuss the whole nature of the evidences which were discovered by Messrs. Brodie and Beckles, and described by Dr. Falconer and Prof. Owen. Such forms as *Plagiaulax*, *Spalacotherium*, or *Triconodon*, are of the highest interest to paleontologists. Whether we interpret the *Plagiaulax* by the analogy of *Hylacoleo*, and consider it to have been carnivorous, or by the affinities which it undoubtedly bears to the existing *Hypsiprymnus*, and classify it as a vegetable feeder, or whether we compare it, for example, with such forms as the pigmy *Dactylopsila*, discovered by Mr. Wallace in the Aru islands (*Proc. Zool. Society*, 1858, p. 109), there exists much scope for discussion; and we can only rejoice that it is especially to Englishmen that the discovery of all these remarkable forms in Mesozoic strata is due.—*The Reader*, June 25.

20. *On the transitions between the subdivisions of the Lias and Oolite in England;* by Prof. A. C. Ramsay, F.R.S., etc.—Mr. Ramsay, in his address delivered at the recent anniversary meeting of the Geological Society of London, after discussing the characters of the subdivisions of the Lias and Oolite, states the following general conclusions:

"The greater inferences that may be drawn from this general survey of the phenomena are:—

1. That there are 13 species common to the uppermost part of the Upper Lias and the Oolite. The break is by no means complete.

2. That progressively, from the lowest to the highest Oolitic formations, large percentages of species pass upward without any approach to a total break either in the whole or in individual groups, excepting in the instance of the Cephalopoda of the Inferior and the Great Oolite.

3. That species often disappear from an intermediate formation to reappear in a higher one, and the principle of migration and return is thus established.

4. That, notwithstanding migration and passage of species, it might perhaps be safely inferred that between the lowest and the highest Oolitic formation many forms had disappeared altogether, so greatly are their numbers diminished in the higher strata.

5. It seems not unlikely that, notwithstanding the large community of species, the succession of the Oolitic formations is not unbroken by minor gaps unrepresented by strata, of the kind explained in my last address. We are aided in this conclusion by a consideration of the physical conditions under which the Oolitic rocks present themselves. Thus the Inferior Oolite attains its maximum development near Cheltenham, where it can be subdivided at least into three parts. Passing north, the two lower divisions, each more or less characterized by its own fossils, disappear, and the Ragstone northeast of Cheltenham lies directly upon the Lias, apparently as conformably as if it formed its true and immediate successor, while at Dundry the equivalents of the upper freestones and ragstones (the lower beds being absent) lie directly on the exceedingly thin representative of the Upper Lias. In Dorsetshire, on the coast, the series is again perfect, though thin. Near Chipping Norton, in Oxfordshire, the Inferior Oolite disappears altogether, and the Great Oolite, having first overlapped the Fuller's Earth, passes across the Inferior Oolite, and in its turn seems to lie on the Upper Lias with a regularity as perfect as if no formation anywhere in the neighborhood came between them. In Yorkshire, the changed type of the Inferior Oolite, the prevalence of sands, land-plants, and beds of coal, occur in such a manner as to leave no doubt of the presence of terrestrial surfaces on which the plants grew, and all these phenomena lead to the conclusion that various considerable oscillations of level took place in the British area during the deposition of the strata both of the Inferior Oolite and of the formations that immediately succeed it.

Again, near Kempston, in Bedfordshire, the Cornbrash and Kelloway rock are both absent, and the Oxford clay was pointed out to me by Mr. Howell, resting directly and apparently quite comformably on the great Oolite. The fragmentary character of the Portland rocks is confessed by all.

It is probable that the oscillations of level that these phenomeua indicate may be intimately connected with the loss of old, and the appearance of new, species in our area; for it is certain that apparent conformity, as in the case of the Great Oolite lying on the Upper Lias, is often deceptive, and is in itself no positive proof of direct sequence; and it is

not unlikely that during gaps in the regular sequence of formations, of some of which we may have no traces remaining, many old forms died out or changed, and new ones, at intervals, migrated hither. At the same time, it is clear that the breaks in succession in these Mesozoic strata are very different in magnitude from those of the Paleozoic age that were accompanied by total unconformity."[1]

Mr. Ramsay, in his address, next considers the Purbeck and Wealden strata, his remarks on which he commences as follows:

"We now come to a period in the geological history of the British marine Mesozoic rocks in which, though not accompanied by much apparent physical disturbance, the break in the succession of *species* is as great as in any part of the Paleozoic series. *I allude to the total change of species that marks the introduction of the marine Cretaceous formations.*

That this break in paleontological succession was accompanied by an enormous lapse of time, is proved by the presence of the Purbeck and Wealden strata lying between the Oolitic and Cretaceous series; and, but for them, when the two series come in contact, so conformable, apparently, are the Cretaceous to the Oolitic rocks, that, unlike some of the cases cited with regard to the Paleozoic formations, we have, by disturbance and denudation of the Oolite strata previous to the Cretaceous period, no very obvious hint of the enormous lapse of time that lay between the two great marine periods.

21. *On the Permian Rocks of the Northwest of England, and their extension into Scotland;* by Sir R. I. Murchison, K.C.B., etc., and Professor R. Harkness, F.R.S., F.G.S.—In this paper the authors propounded a new view of the composition of the Permian Group in the northwest of England, and, by the consequent re-arrangement of the rocks involved in this change in classification, they were enabled to place the Permian strata of Great Britain in direct correlation with those of the continent of Europe. This new feature in British classification is the assignment of a large amount of red sandstone in the northwestern counties to the Permian period, and its removal from the New Red Sandstone, or Trias-formation, to which they have hitherto been assigned in all geological maps. The authors showed that these red sandstones are closely and conformably united with the Magnesian Limestone, or its equivalent, and form the natural upper limit of the Paleozoic deposits. They affirmed that thus a tripartite arrangement of the Permian rocks holds good in Westmoreland, Cumberland, and Lancashire, and that the three subdivisions are correlative with those formerly shown by Sir R. I. Murchison to exist in the Permian deposits of Germany and Russia, thus proving the inapplicability of the term Dyas to this group of rocks.

The difference in lithological details of the Permian rocks of the northwest of England from those on the opposite side of the Pennine chain, was next adverted to; and it was observed that, with so vast a dissimilarity in their lithological development in England, we need not be surprised at finding still greater diversities in these protean deposits when followed into Germany and Russia.

[1] They are, however, somewhat comparable to the relations of the Lower and Upper Llandovery rocks to each other, or to the variations in the subdivisions of the magnesian limestone, which were formed during minor oscillations of level.

The discovery, by Professor Harkness, in the central member of this siliceous group in Westmoreland, of numerous fossil plants identical with the species of the Kupferschiefer in Germany, and in the Marl-slate of the Magnesian Limestone of Durham, was given as a strong proof of the correctness of the authors' conclusions.

The comparative scarcity of igneous rocks, and the evidence of powerful chemical action, in the Permian strata of Britain, is contrasted with their abundance in deposits of that age in Germany; but proofs are nevertheless brought forward to show that the hematite of Cumberland and Lancashire was formed in the early accumulation of the Permian deposits.

In describing in detail the different members of the Permian group of the northwest of England, the authors define the downward and upward limit of the strata which have undergone dolomitization; for whilst certain bands of calcareous breccia (the "brockrum" of the natives), which occur in the central portion of the series, contain much magnesia, the lower breccias, composed of the same mountain-limestone fragments, have no trace of it; nor is it to be detected in the upper member, or St. Bee's Sandstone.—*Phil. Mag.*, [4], xxvii, 542.

22. *On the Reptiliferous Rocks and Footprint Strata of the Northeast of Scotland;* by Professor Harkness, F.R.SS. L. & E.—The author showed that the foot-print sandstones of Rossshire constitute the upper portion of the *Old Red Sandstone* formation, and that the strata embraced in a line of section from the Nigg to Cambus Shandwick, from above the gneiss to the foot-print sandstones of Tarbet-ness inclusive, are conformable throughout, and are referable to each of the three divisions of the Old Red Sandstone—namely, the conglomerates and yellow sandstones (of a thickness of 1500 feet) belonging to the Lower Old Red Sandstone; the gray flaggy sandstones and shales of Geanies—the equivalent of the Caithness flags—containing *Osteolepis*, *Coccosteus*, and *Acanthodes*, and thus referable to the Middle Old Red; thirdly, conformable strata, consisting of conglomerates, and foot-bearing and other sandstones, appertaining to the higher members of the system. The foot-bearing sandstones have a thickness of 400 feet, and represent the reptiliferous sandstones of the Elgin area, though not overlaid by Cornstones, as in that district. The author, in conclusion, remarked that, though *Stagonolepis* is decidedly *Teleosaurian* in its affinities, it does not consequently mark a Mesozoic group of rocks; for *Mastodontosauriæ*, which abound in the Trias, occur in the Coal-measures; and stratigraphical evidence shows us that Teleosaurian crocodiles have a wider geological range, since they are met with in the Old Red Sandstone.—*Proc. Geol. Soc.* in *The Reader, July* 9.

23. *Coal in Venezuela.*—Dr. Seeman, who has been several months in Venezuela for the purpose of inspecting an estate of 100 square leagues on the banks of the river Tocuyo, has returned to England by the last West India steamer. Whilst exploring the valley of the Tocuyo he has discovered what may prove of the utmost importance to the railways and steamers now establishing in that part of the world—extensive coal-beds, the coal being valued in London at thirty shillings per ton, and resembling the best Welsh steam coal. This part of South America is as

yet little known, but abounds in natural wealth; in it are situated some of the richest copper mines of the world—those of Aroa, to which an English company is now making a railroad, sixty miles in length, ten of which have already been finished. The soil is of extreme fertility, and mahogany and other precious woods abound.—*Reader*, *No.* 74, *May* 28, 1864.

24. *On the Geology of Arisaig, Nova Scotia;* by the Rev. D. HONEYMAN, F.G.S.—A careful examination of the country in the neighborhood of Arisaig enabled the author to construct three sections and a map showing the geological constitution of the district. Two of these sections were nearly parallel to one another, running from N. to S., and taken some distance apart, while the third was nearly at right angles to the other two; thus a tolerably accurate idea of the geology of the country could be obtained. The author described each of these sections in detail, giving lists of the fossils found in the different beds, which proved them to be of Upper Silurian age; and he further considered that they justified the adoption for the subdivisions of these Nova-Scotian Silurians of the terms May-hill, Lower Ludlow, Aymestry, and Tilestones, the first and third of which had been used for them previously by Mr. Salter. Beside Silurian rocks, there occurs in the western part of this district a conglomerate of Lower Carboniferous age, while trap-rocks occur on the north and south.—*L. E. and D. Phil. Mag.*, [4], xxviii, 74.

III. BOTANY AND ZOOLOGY.

1. *New Scirpi of the Northern United States.*—Among the species which, by continued research, are one by one added to the Flora of the Northern United States, are a few *Scirpeæ*, to which we may here call attention.

The most conspicuous addition is that of a tall *Scirpus* of the *triqueter* section, which was last year discovered by Mr. A. Commons and Mr. Wm. M. Canby, on the eastern shore of Maryland, and which has been named *S. Canbyi*. It is as tall a species as *S. Olneyi*, but has its radical leaf remarkably developed, as also the involucral one, which apparently continues the stem; and the spikes, which are half an inch long, are all on long and slender rays, which come off in pairs from the nodes of a zigzag rhachis, from the axils of bracts or involucels. The character which was published in January last, in the Proceedings of the Academy of Natural Sciences, Philadelphia (in a note appended to a short article by Mr. Canby on the plants of the lower part of Delaware and the Eastern Shore of Maryland), is here reproduced.

SCIRPUS CANBYI (Gray, supra cit.): culmo elato (3–5-pedali) folio prælongo canaliculato-triquetro stipato inferne obtuse trigono superne triquetro apice in involucrum monophyllum pseudo-umbellam plurifloram longe superans desinente; umbella sessili dichotomo-composita; umbellulis sæpissime biradiatis involucellatis, radiis omnibus elongatis plerisque monostachyis; spicis oblongis; squamis laxe imbricatis oblongo-ovatis acutiusculis dorso viridulis nervosis marginibus late scariosis pallidis; setis perigynii 6 patentim barbellatis achenium obovato-triquetrum subito rostellatum paullo superantibus.

Two or three years ago we identified *Scirpus pauciflorus* in the Northern States, on occasion of its being sent from the northern part of Illinois by Dr. George Vasey. We then ascertained that it had long before been gathered on the northern borders of Michigan and of the State of New York (vide Manual Bot. Addend., 1863, p. xcviii), but had been confounded with the very distinct *S. planifolius*. We have this summer received from another part of our northern frontier, viz: from the vicinity of Buffalo, New York, still another *Scirpus* of this group; one which might more naturally be confounded with *S. planifolius*, but which may be neatly, and we trust definitively, distinguished by the following diagnosis:

Scirpus Clintonii (sp. nov.): folio e vagina suprema involuto-filiformi culmo multùm breviori, cæteris brevissimis vel subnullis; squamis capituli (præter infimam) carina vix prominula haud percurrente muticis; setis perigynii achenium subsuperantibus: rel. ut in *S. planifolio*.—On the plains between Buffalo and Williamsville, New York, Hon. George W. Clinton, June, 1864.—The hypogynous bristles are perhaps rather longer, and more strongly barbellate with spreading hairs than in *S. planifolius;* and the achenium may be rather smoother; otherwise no difference is noticeable. We should not rely much upon the short, narrow, and involute-filiform or setaceous leaves, if they were not accompanied by pointless scales of the spike; the midrib or keel, instead of projecting into a cusp as in *S. planifolius*, vanishing quite below the blunt and scarious apex of the scale. In naming this species after its discoverer, we welcome back, with this gift in his hands, a deserter of thirty years from the botanical ranks, into which he enlisted in youth, and from which he was led away by the demands of an exacting profession. And we confidently wish him a success worthy of his name and lineage in his laudable endeavors to promote a knowledge of the botany, and to complete the public herbarium, of his native State.[1]

Scirpus cæspitosus, L., a northern subalpine species, which Dr. Pitcher, however, had collected at the outlet of Lake Superior, and we had ourselves met with on the higher mountains of North Carolina, has this year been detected at Ringwood, in the northern part of the State of Illinois, far distant from any mountains.

Eleocharis simplex, Torr., has to be added to the Flora of the Northern States, having been detected by Mr. Wm. M. Canby, in 1863, on the Eastern Shore of Maryland.

Eleocharis rostellata, Torr., has been this year detected in the New Durham swamp, New Jersey, by Dr. T. F. Allen. A. G.

2. De Candolle, *Prodromus Systematis Naturalis Regni Vegetabilis, etc. Pars decima quinta. Sectio prior.* May, 1864.—This new part of the *Prodromus*, although ranking as only the first portion of the 15th volume, occupies 522 pages, has its proper index, and is intended to be separately bound. The other part, which will be yet larger, is devoted to the *Euphorbiaceæ;* and a fasciculus of it, containing the genus *Euphorbia*, was issued in the year 1862. The volume now before us con-

[1] We learn from Dr. Torrey that he has for some time had this *Scirpus* in his herbarium from Ogdensburgh, N. Y., also from Michigan, and that he takes it to be a variety of *S. planifolius*.

tains the *Lauracæ*, by Meissner (a vast improvement upon Nees von Esenbeck), and the small group of *Hernandiaceæ* by the same; the *Begoniaceæ*, by Alphonse De Candolle himself, followed by the *Datiscaceæ* and the *Papayaceæ*, by the same; the *Aristolochiaceæ*, by Duchartre; and finally the *Stackhousiaceæ* by Bentham, the latter reduced to a single genus, of eleven species. The volume is an important one, especially for tropical botany. A. G.

3. *Bryology of British N. W. America.*—The most interesting article to us in the last (29th) no. of the *Journal of the Proceedings of the Linnæan Society*, issued in June last, is an elaborate one by Mr. Mitten, entitled, *The Bryologia of the Survey of the 49th Parallel of Latitude.* It is founded on the specimens gathered by Dr. Lyall, who, as our readers know, was the assiduous botanist of the British N. W. Boundary Commission. East of the Rocky Mountains and upon them he was gleaning after Drummond, who left nothing for his successor to discover. But on the western side, and on Vancouver's Island, he found much that was novel and interesting. While publishing the new species now brought to light, Mr. Mitten also revises the collections of Drummond, both the Northern and the Southern Mosses, and characterizes a goodly number of species which had remained obscure and undistributed, or had been confused with others. Again, others are described from Bourgeau's, Coulter's, Fendler's, and Wright's collections. A good set of the duplicates of Lyall's and Bourgeau's muscological collections, sent to this country, has been placed in the hands of Mr. Sullivant. A, G.

4. *Icones Muscovum;* by Wm. S. Sullivant.—We are able to announce that this, the most exquisite of all illustrated bryological works, has been printed, and is about to be issued. It forms an imperial 8vo volume, with 129 copper-plates of unrivalled execution. A. G.

5. *On the Currant Worm of Ann Arbor, Michigan;* by Prof. A. Winchell. (Condensed from an article in the Detroit Free Press of July 9, 1864.)—This "currant worm," is the larve of a Hymenopter of the genus Selandria, and is named *Selandria Ribis* by Prof, Winchell. It was observed by him last summer. This summer it has been still more abundant, and has, in places, completely denuded the red currant bush of its foliage, doing it considerable injury, though for the present year the crop of fruit does not seem materially deteriorated.

The worm was first seen, May 23. Individuals were then about one-fourth of an inch in length, and had just begun to depredate upon that part of the foliage nearest the ground. They devoured rapidly the whole tissue of the leaf, leaving only the thicker part of the nerves, and moved from leaf to leaf, gradually extending their ravages toward the summits of the stems.

The full grown larve is three-fourths of an inch in length, of a pale-green color, with black head, tail and feet, and numerous black spots regularly arranged around the body, from the summit of each of which proceeds one, two or more short, stiff hairs. Number of segments of the body 14 (including head and tail), of which the 2d and 12th, are yellowish green. The 2d, 3d and 4th segments are furnished each with a pair of feet; the 5th is short and without feet; the 6th, 7th, 8th, 9th, 10th and 11th with short, extensile prolegs—that is, fleshy protuberances, to be used as legs; 12th and 13th, segments without legs.

The larves all disappeared about the 3d of June, undergoing first a moulting, and then digging their way into the ground.

On the 16th of June, a swarm of four-winged flies (Hymenopters) were seen under the currant bushes. They were generally inactive or sedentary, but at intervals became extremely excited, and I observed that these spells of activity were occasioned by the presence of a female insect about which there were hundreds of males. It appeared that the females were very few in number, and each moved as a queen among her subjects.

The males are one-fourth of an inch in length, and the females three-eights, and much thicker. The color of the latter is uniformly ochre-yellow except the head and wings, while the male has, in addition, considerable black upon the back.

The queens proceeded immediately to deposit their cylindrical, whitish transparent eggs, in regular rows along the underside of the nerves of the leaves, attaching them at the rate of about one in forty-five seconds.

The ova appeared, under the microscope, at first to be filled with a granular fluid, which, in a few hours, became divided into distinct areas. On the second day the outline of the embryo was traced, and it was seen bent together with protuberances for the feet distinctly forming. On the third day nearly all parts of the external and internal structure were visible—the pulsating dorsal vessel, the intestine, the tracheary or breathing system, the mandibles, the feet, etc.; and the animal moved in its nidus. On the fourth day the embryo escaped from the egg and began to eat. This is the most rapid embryonic development I have ever witnessed.

When the larve first escapes, it is whitish, and one-tenth of an inch in length. It becomes one-third larger in twenty-four hours, and attains full growth by the 25th of June. The brood then begins to moult and descend into the soil as before. In this situation it probably remains until the succeeding spring.

The following is then a summary of its history:

May 17th, first brood of flies appear from larves or worms which went into the soil the previous summer. May 21st, first brood of larves, becoming noticeable about May 23d. June 3d, moulting and burrowing in progress. June 16th, appearance of second brood of flies. June 20th, second brood of larves escaping from egg. June 25th, flies disappear. June 28th, moulting and burrowing of second brood.

Incubation of ovum three or four days: time to moulting and burrowing eight days; time in burrow, first brood, thirteen days; life-time of fly nine days.

The usual torpidity of the fly prevents the rapid spread of this pest, but measures ought to be taken to resist its encroachments. I find that the full grown larve is not injured by ashes or lime, though these applications are fatal to the young one. Whale oil, soap suds, or infusion of tobacco stems will destroy them. The simplest method, however, is to jar the bushes over pans or cloths. The larves are very easily detached. There is no doubt that the strong odors of coal tar and petroleum would drive away the flies; but it would not cause their death.

6. *Casts of various parts of the structure of the Gorilla.*—Dr. Auzoux announces that having recently received a specimen of the gorilla through Admiral Didelot, he has, by his "processes of plastic anatomy," made

casts of great perfection of the following parts in the structure of the animal:—

The complete osteology—the skeleton being 1 m. 1 c. in length, and so like the original bones in appearance that it might easily deceive.—2. The myology, and all the viscera enclosed in the three larger splanchnic cavities. All these parts are so arranged that they may be studied in their natural positions, or taken up one after another for minute examination. The various peculiarities of the bones, the muscular insertions, the arrangement of the great aerial sacs which communicate with the larynx, the little development of the brain as compared with man, are among the points illustrated which are of special interest.

Dr. Auzoux proposes soon to add to the osteological, myological and splanchnological specimens, others illustrating the vessels and nerves.—*Les Mondes*, May 26.

7. *Animalcules in the blood.*—Dr. HARLEY of London, in a recent memoir on the disease called *Hæmaturia*, occurring at the Cape of Good Hope and the Island of Mauritius, shows that the disease is owing to the presence of a species of *Distoma* in the blood. Dr. Harley described it as a new species, after a study of the eggs and the embryos of the worm, and called it *Distoma Capense;* but Dr. Cobbold, who is especially versed in the science of intestinal worms, states that it is the *Distoma hæmatobium*, and that the disease is the same that is well known in Egypt. The same worm was discovered by Dr. Cobbold in the body of an African monkey (*Cercopithecus fuliginosus*), and as the species had previously been recognized by Dr. Bilharz of Cairo, the generic name, *Bilharzia*, has been applied to it. This parasite is introduced into the body of man and monkeys from the unfiltered waters of the African rivers. The larves live in some of the mollusks of the rivers.

8. *Cephalic vertebræ.*—Mr. LAVOCAT, of the Academy of Sciences of Toulouse, has presented the following observations on a monstrosity as confirming his view that the head corresponds to four vertebræ, one to each of the senses. A calf, at half-development, had the left half of the head quite regular, while the right was deprived of the nose and eye. On this same right side there were suppressed the osseous pieces constituting the nasal segment (the *vomer*, and *ethmoid*) and those which constitute the arch protecting the eye (*frontal, anterior, sphenoid*, and *pterygoid*). On the left side all the parts were present, as well as the corresponding organs of sense. This observation, he says, demonstrates as completely as possible a natural concordance of development between each organ of sense and the cephalic segment which protects it. The parts degraded, in the several cases of anomaly, are exactly those which are attributed by Mr. Lavocat to the several cephalic segments considered as vertebræ.—*Les Mondes*, May 26.

9. *Marine Crustaceans in freshwater lakes of Norway.*—G. O. SARS (son of Prof. Sars) has detected in one of the freshwater lakes of Norway, a red Copepod, the salt-water species *Harpacticus chelifer* of Lilljeborg, and in another, the *Mysis relicta* of Loven, also marine. It is supposed that they must have been introduced when the region was submerged beneath the sea, in the Post-tertiary period, and that they have survived the change to freshwater. A species of *Gammarus* (probably the *G. cancelloides* Gersfeldt) occurs with the latter species, which is also

found in Lakes Baikal and Angara; and this also is regarded by Loven as originally marine.—*Ann. and Mag. Nat. Hist.*, [3], xiii, 437.

10. *Hymenoptera.*—The following papers on American Hymenoptera by E. T. Cresson have been published in the course of the two years past in the Proceedings of the Entomological Society of Philadelphia. Proceedings for June 1863, *On a new species of Massaris;* for July 1863, *List of the N. American species of Bombus and Apathus;* for Nov. 1863, *On the N. American species of the genus Nomada;* for Feb. 1864, *On the N. American species of several genera of Apidæ;* for April 1864, *Descriptions of North American Hymenoptera—Apidæ.*

11. *Didunculus.*—At the meeting of the Academy of Natural Sciences of Philadelphia, of March 15th, Mr. Cassin called attention to the collection of birds presented by the Smithsonian Institution, and particularly referred to several species of great rarity and scientific value. The *Didunculus strigirostris* is one of two species of birds now known to be approaching extinction, the other species being *Alca impennis*, which is also in the Academy Museum. This bird is most nearly allied to the extinct Dodo, formerly of the Isle of France, and inhabits the Samoan or Navigator Islands. Its extinction or approach to it is said to be owing to the introduction into those islands of the domestic cat. Not more than four or five specimens are known to be extant.

12. *Note on the Muscovy Duck;* by Mr. Hill. (Proc. Acad. Nat. Sci. Philad., 1864, p. 72.)—The habitat of the Muscovy Duck is the Lake of Nicaragua. There travellers see them at all times, either in small breeding coteries, or large flocks. In the wild state their plumage is dark without any admixture of white. They were originally procured from the Mosquito shore, the country of the Muysca Indians, (see Humboldt's researches,) and hence is derived the name of Musco duck, corrupted into Muscovy duck. The West Indian Islanders had early naturalized them, for, on the discovery of Columbus, they speak of "ducks as large as geese," that they found among the Indians.

13. *The Elements of Comparative Anatomy*, by Thomas Henry Huxley, F.R.S., Prof. Nat. Hist. Royal School of Mines, and Prof. of Comp. Anat. and Phys. to the Roy. College of Surgeons of England. 304 pp., 8vo, with numerous cuts. London, 1864. John Churchill & Sons.—The two subjects of this volume are, *first*, the Classification of Animals, and *second*, the Vertebrate Skull. On both topics the author writes learnedly, but shows a better appreciation of details and their outer relations than of the profound system of Nature. Instead of four subkingdoms of animals, the author makes eight "primary categories or groups"—viz., the *Vertebrata*, *Mollusca*, *Molluscoida*, *Cœlenterata*, *Annulosa*, *Annuloida*, *Infusoria*, and *Protozoa*.—The subkingdoms of Mollusks and Articulates are subdivided, the former into Mollusca and Molluscoida, and the latter into Annulosa and Annuloida; yet with an expression of the possibility that "characters may be discovered which shall unite these pairs respectively;" and the "Radiate-mob," as he, with more feeling than philosophy, styles the subdivision of Radiates, (for even Cuvier, although he failed to see the precise limits of the division, comprehended the true idea at the basis of it,) is cut up—part (the Acalephs and Polyps) being retained in one group called the *Cœlenterata*, and the others (Echinodermata) being united with the Scolecida to make

the *Annuloida*. Such a system is arrived at by making the characters of the nervous system, digestive system, and others of the means by which the grand plans of structure are adapted to forms of differing grades, or of different conditions of existence, superior in importance to the fundamental plans of structure themselves.

The preface states that it is the intention of the author to make this work the first of a series—to be followed by a second "On Man and the other Primates;" a third on the remaining Mammalia, and others,—so as eventually to bring out "a comprehensive, though condensed, systematic work on Comparative Anatomy."

14. *Notice of the Megatherium Cuvieri, the giant fossil Ground-Sloth of South America, presented to the University of Rochester by Hiram Sibley, Esq.* 34 pp., 4to.—The Geological Cabinet of the Rochester University lately received, through the liberality of Mr. H. Sibley of that city, a copy in plaster of the Megatherium Cuvieri. The volume here announced, prepared by Prof. Henry A. Ward of the University, contains a brief account of the discovery, anatomical characters, and probable habits of the Megatherium, derived from the memoir of Prof. Owen and other publications on the subject, together with a few cuts, one of which exhibits the specimen as it stands in the Museum. There are also short notices of some related animals.

15. *Recherches sur la Faune Littorale de Belgique*, par P.-J. Van Beneden, Prof. à l'Univ. Cath. de Louvain.—Crustacés.—Memoir présenté à l'Académie royale de Belgique le 6 Mai 1860. 180 pp., 4to. Bruxelles, 1861.—This extended memoir is a continuation of the former papers of Van Beneden on the fauna of the Belgian coast. It treats descriptively, and in part embryologically, of many of the species there found.

IV. ASTRONOMY.

1. *Note on a Meteor;* by John Gardner. (In a letter to the Editors, dated Boston, Mass., July 26th, 1864.)—On the evening of the 13th, at about quarter past ten o'clock, I had the pleasure of seeing a large and most beautiful meteor; and yesterday I noticed a short paragraph in the *Post*, stating that on the evening in question a meteor as large as Jupiter had been seen in Hartford, Conn. It will be interesting to learn if possible whether the latter was the same body which was seen here.

I was walking along the *west* side of Washington street, and toward the city from Roxbury, when my attention was suddenly arrested by the appearance of a very large ball of fire, extremely brilliant, similar to the appearance of *Vega* in a telescope with a low power. The houses on the opposite side were high, but the street at this part is wide. The sky was clear in the direction I was looking, and, though the moon was shining, the larger stars shone out definitely enough to enable me to trace their respective positions to each other. When the meteor first caught my eye it seemed a little below *Delphinus*, and pursued its path in a northeasterly direction toward *Pegasus*. At first it was merely a ball without any tail, but suddenly it appeared to start along with fresh vigor; a tail of at least 3° or 4° was produced with a *rushing noise*, and then the body itself exploded with a *loud report* (which, in spite of all

the noise and bustle of the street, cars, &c., was most plainly distinguishable) and then died out.

In the annexed diagram it seemed to appear first at point A. The tail, which remained two or three seconds in view, had the appearance of myriads of particles of luminous matter condensed into a cigar-shaped form, hissing as it went along like a rocket; but unlike a rocket it did not make its appearance until almost immediately previous to the explosion.

Now as Hartford is 100 miles southwest of Boston, and as the view I had was in a direction opposite to that of Hartford from Boston, and taking into account the angle of elevation as shown by the height of the building near me, I think this body must have been a very large one and at a very great distance.

2. *List of Radiant Points of Shooting Stars;* by Professor Heis.—This paper consists of a list of all the radiant points of shooting stars observed and recorded during eleven years before 1860, at other times of the year than in August, November, and December. They are arranged as general radiant points of shooting stars, or as general centres of emanation of shooting stars, in successive half-months of the year from January to December, omitting only the latter half of July, the first half of August, the latter half of October, the first half of November, and the first half of December, concerning which Professor Heis has published his observations in detail. The present radiants have not yet been published, but will be published by Professor Heis in the ensuing winter. It is curious that *δ Virginis* occurs in this list as a general centre of emanation of shooting stars in the latter half of April, traceable also in May! This perfectly incidental coincidence is, Mr. Herschel considers, a fair sequel to his discovery of a star-shower existing on the 10th of April; because, after a well-marked star-shower, a number of shooting stars may always be seen to come for a considerable time from the same point of the heavens, and such shooting stars are sure to be picked out from other sporadic shooting stars by their common intersection. Mr. Herschel also thinks that there will be found, at last, to be no such meteors as sporadic shooting stars, but that all belong to some special star-showers, whose effects remain sensible for some time, and whose dates and radiant points have not yet been thoroughly examined.—*Proc. Roy. Astronom. Soc.*, in *The Reader*, July 9.

3. *New Comet.*—Mr. Tempel discovered a new comet on the 5th of July, having the appearance of a diffused nebulosity of some 3′ or 4′ in diameter. This comet was seen by Mr. Respighi at Bologna, on the 6th, and by Prof. F. Karlinski of the Cracow Observatory, on the 11th, near *γ Arietis*.

Mr. Valz gives the following approximate elements. Passage of perihelion Sept. 7·05, mean time at Marseilles; dist. of perihelion 1·823; long. of perihelion 289°·37; R.A., 66°·56; inclination 1°·45; movement retrograde.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Further Human remains from the Quarry of Moulin-Quignon, near Abbeville, France.*—The long discussion which has taken place over the human jaw-bone asserted to have been found at the quarry of Moulin-Quignon has given great interest to explorations at that place. At the meeting of the Academy of Sciences of July 18th, Mr. de Quatrefages presented the results of new discoveries of human remains in communications from Mr. Boucher de Perthes. From these communications it appears that on the 24th of April last, Boucher de Perthes, along with Dr. Dubois, physician of the Hotel-Dieu at Abbeville, found, in a yellowish-brown bed to the right of the quarry, a portion of a human sacrum, fragments of other bones, some of which were parts of a cranium, and a human molar tooth. On the 1st of May, they obtained, on further digging, three small fragments of a cranium and a part of a tooth. On the 12th of May, Mr. Boucher de Perthes was joined by Mr. H. Duval. They procured from the brownish-yellow bed, at a depth of six to seven feet, portions of a cranium.

On the 11th of May, besides fragments of bones, a *human jaw-bone* was turned out, which was perfect excepting the extremity of the right ramus and the teeth. The depth from which it was obtained was about fourteen feet. Boucher de Perthes, being occupied with investigations elsewhere at the time, was not himself present; but a person delegated by him superintended the digging. Fragments of bones and some cut flints also were found.

On the 7th of June, the Abbé Martin, Curate of St. Gilles, Professor of Geology in the Seminary of St. Riquier, continued the diggings, during the temporary absence of B. de Perthes, and took out from the bed, at a place where it showed plainly by its regular stratification that it had not been disturbed since its first deposition, a *human cranium*, the frontal bone and the two parietal of which were nearly entire, and also two fragments of an upper jaw (perhaps of the same head with the cranium) and an iliac bone.

The number of specimens of bones collected amounts to 200, and they were all found within an extent of about 130 feet. Part are of animals, a catalogue of which is soon to be made out. The human remains apparently indicate a very small race of men.—*Les Mondes*, July 21.

2. *Interoceanic canal across the Isthmus between the two Americas.*—The idea of opening an interoceanic canal across the isthmus between the two Americas dates almost from the discovery of America. As early as 1528 Antonio Galvao, a Portuguese navigator of the sixteenth century, relates in his work, *Tratado dos Descubrimentos* (p. 73), that Sayavedra, in 1528, proposed to the Emperor to open communication between the two oceans, which, he says, is possible at four different points: 1, from the Gulf of Miguel to Uraba (Gulf of Darien); 2, from Panama to Nombre de Dios; 3, by Lake Nicaragua and the river San Juan; 4, by the isthmus of Tehuantepec. What is very remarkable, these four routes are actually the only ones which admit of the construction of an interoceanic canal, as has been demonstrated by all recent investigations, and especially by those made since 1825.—*Cosmos*, July 7.

3. *Note supplementary to the article on the Progress of the Geological Survey of California* (pp. 256–264).—Since the article on pages 256–264 was printed, a very interesting account has been received from Prof. Brewer, of a portion of his explorations in company with Messrs. Hoffmann, King, and Gardner, (referred to on p. 258). The party had made an extended reconnaissance in the High Sierra, between the parallels of 36° and 38°, starting from Visalia, and exploring the region of the headwaters of Kaweah and King's rivers. Contrary to our previously-formed opinions, based on all the information we had been able to obtain with regard to this entirely unknown portion of the State, it proves to contain the most elevated, as well as the wildest and grandest part of the Sierra. Indeed, it seems, from Prof. Brewer's letter, that it is possible that Mt. Shasta itself will be overtopped by one or more of the gigantic peaks discovered on this exploration. July 2d the party climbed a sharp granite cone which proved to be about 13,500 feet high, of the view from which Prof. Brewer writes as follows: "The snow peaks here form a belt from thirty to forty miles wide, over the whole of which rise extremely sharp granite ridges over 11,000 feet high, and there are *hundreds* of points over 12,000 feet. This cone is not less than 13,500 feet and perhaps 13,600! To our surprise, it proves not to be on the true crest, which is fifteen or twenty miles east of us, and there were in sight from it at least ten other peaks as high, several that were higher, and one that will probably reach 14,000 feet or very near it." One of these more elevated peaks was visited and ascended by Mr. King, July 6th—as may be supposed, not without great difficulty. It was found to be over 14,000 feet high, and it was also found that there were five more peaks as high as that one, and two higher, one of which it seems possible may exceed Mt. Shasta in altitude. These grand elevations lie between the heads of King's and Kern rivers, somewhat north of the north end of Owen's lake. The highest peaks can be best visited from the Owen's lake and Visalia trail, and probably only from that direction. Mr. King started about the middle of July to attempt to reach them, an enterprise the arduous character of which will not be appreciated except by the few who have undertaken pioneer-work of this kind. In the next number of the Journal I hope to be able to record his success in an exploration so interesting and important in its character. It would seem, therefore, that we have in this district, just visited by the Geological Survey, the greatest mass of mountains, taking width and average elevation into consideration, which has yet been discovered within the limits of the United States, and perhaps on the North American continent. And it may seem strange that this fact should have remained undiscovered so long. But it must be remembered that the region is an inconceivably rough and difficult one to reach, and that we have never been able to learn that it had been visited by any scientific man, hunter, or mineral-explorer even: all we knew of it was, as I have said on p. 258 of this Journal, "that it contained some of the loftiest and most extensive mountain groups of the Sierra." To make the statement more correct, it now appears that the words "some of" should be omitted.

The High Sierra in this region also, as well as farther north, abounds in traces of ancient glaciers, on a scale of unsurpassed magnitude.

Northampton, Mass., Aug. 11th. J. D. W.

4. *A New Silkworm.*—A *fourth* species of silkworm of the oak—the *Bombyx Roylei*—has been introduced into France. The three before introduced are the *B. mylitha* Fabr., from Bengal, *B. Pernii* Guerin-Mèneville, from North China, and *B. Yama-maï* G.-M., from Japan. The new species is from the plateaus of the Himalaya, on the frontiers of Cashmere. It lives on a thick-leaved oak, the *Quercus incana*. Guerin-Mèneville states that the worm can be easily acclimated in central and southern France. Twenty coccoons received on the 23d of March gave 3 males on the 7th of April, and, on the 19th, a male and female. Soon after, 108 eggs were laid, enough to insure the success of the experiment of introducing the species and distributing it over the country. Instructions for the care of the *Yama-maï* of Japan, published in Guerin-Mèneville's *Revue de Sericiculture comparée* (1863, p. 33), serve also for the new species.—*Cosmos*, Ap. 28.

5. *A new style of barometer; effect of atmospheric pressure on practice in Gunnery.*—The French artillerists in Mexico have recently found, to their surprise, that the angle of elevation used in France for their guns, for any given range, does not afford the calculated results; and have ascertained that this is owing to the diminished pressure of the atmosphere on the Mexican plateau. It follows that cannon may serve as a kind of barometer for measuring altitudes.—*Les Mondes*, July 7.

6. *Paper from Maize.*—In the manufacture of paper from maize, which has been started in Austria, the leaves are digested in hot water for two days, at the end of which time they are separable into three parts: (1) the coarse ribs or veins, which serve, like hemp or flax, for making cordage and cloth; (2) the finer material uniting the ribs, which is converted into a soft paste, and which is made into a kind of bread, somewhat dark in color, and of agreeable taste; (3) a coarser paste finally remains, which is perfectly white and which is used in making the paper. The first of these materials may be kept for months in the air without injury. Dried, it is a good combustible; and in the soft state, an excellent fattening material (*engrais*).—*Cosmos*, May 19.

7. *Preservation of wood.*—The following method is used in Germany for the preservation of wood. Mix 40 parts of chalk, 50 of rosin, 4 of linseed oil, melting them together in an iron pot; then add 1 part of native oxyd of copper, and afterward, with care, 1 part of sulphuric acid. The mixture is applied while hot to the wood by means of a brush. When dry it forms a varnish as hard as stone.

8. *Morid's process for recovering writing on paper or parchment which has become nearly effaced.*—The paper or parchment written on is first left for some time in contact with distilled water. It is then placed for five seconds in a solution of oxalic acid (1 of acid to 100 of water); next, after washing it, it is put in a vessel containing a solution of gallic acid (10 grains of acid to 300 of distilled water); and finally washed again and dried. The process should be carried forward with care and promptness, that any accidental discoloration of the paper may be avoided.—*Cosmos*, March 24.

9. *The ravages of Insects a cause of their destruction.*—It is well known that after worms have for 5 or 6 years committed their ravon the trees of a region, they often suddenly disappear, and have no full return again for two or three or more years to come. It has been shown

that the destruction is sometimes at least a result of their numbers. The larves or worms, when very numerous, consume the leaves of the tree on which they are before they attain full maturity, and, as a consequence, they never pass to the chrysalis state; they remain for a while as larves, often showing by their movements that they are half-starved, and then die.

10. *Means of hardening fragile or friable specimens, used by Mr. Stahl.*—Mr. Stahl gives solidity to friable specimens, even if of loose material like a mould in sand of a shell or bone, by running in a mixture of resin and spermaceti melted together.—*Les Mondes*, May 26.

11. *Elevation of Lake Geneva above the sea.*—The mean level of Lake Geneva has been determined, by levelling along the railroads here terminating, to be 372·362 meters above the mean level of the Mediterranean, and 371·562 meters above the mean level of the ocean.—*Les Mondes*, May 26, from the *Arch. Sci. Phys. de Genève*, Jan., 1864.

12. *Investigations in Egypt.*—A legacy of 20,000 francs has been bequeathed to the French Academy of Sciences by Miss A. Letellier, which, under the name of the "Savigny Foundation," is to supply young zoologists with the necessary means of continuing Savigny's investigations in Egypt and Syria.—*The Reader*, June 25.

13. *Isthmus of Suez.*—The canal, which has for some time been in construction, from Ismaïlia to Port Saïd, has been completed, and fresh water is now furnished across the line of the desert, as well as at this important port.

14. *Making of Oases.*—Mr. Martins, in an address at one of the *Soirées scientifiques* of the Sorbonne, gives a glowing account of the effect over the African desert, through French enterprise, in sinking Artesian wells. He predicts the time when immense lines of railways shall run from the Mediterranean to Senegal, and from Senegal to the Red Sea; and when Suez, with its finished canal, shall become "le foyer des relations avec la feconde Afrique, le boulevard de toutes les mers, la route de tous les continents."—*Cosmos*, April 21.

15. *Acclimation of English Birds in Australia.*—The Thrush, Blackbird, Skylark, Starling, Chaffinch, various Sparrows, and the Wild Duck, are already domesticated in Australia through the efforts of the Acclimatization Society of Victoria. Great success has also attended the Society's efforts to introduce good fresh-water fish into the rivers, and it is expected that the Salmon will soon be naturalized in Tasmania.

16. *Dedication of the Museum of the Boston Society of Natural History.*—The new building, recently erected at Boston for the Natural History Society, was dedicated on the 2nd of June last. The building is an elegant and imposing structure of granite, brick and freestone, of the classic style of architecture with Corinthian pilastres, nearly square in outline. At the centre of the east front there is a grand doorway of granite, supported by massive buttresses, on which are hereafter to be placed life-sized figures of an elephant and a rhinoceros cut in stone. It measures 95 feet by 105, and is well arranged within for scientific purposes. It has been erected at a cost of nearly $100,000. Addresses were made by Prof. Wyman, Prof. Wm. B. Rogers, Mayor Lincoln, Lieut. Lutke of the Russian Navy, and Rev. Dr. Waterston.

17. *Universal Exhibition at New Zealand.*—A New Zealand exhibition will be opened at Dunedin, in the province of Otago, on the first

Monday of January, 1865. The building is to be of brick. Its regulations will be similar to those of the last London exhibition. Articles are to be received between the 1st of October and 12th of December, 1864.

18. *British Association.*—The next meeting of the British Association, to be held at Bath, will open on Wednesday, the 14th of September. Sir Charles Lyell is the President for the year.

19. *Sir Charles Lyell.*—Sir Charles Lyell, has been made a baronet, under the title of Sir Charles Lyell, Baronet of Kinnardy, in the county of Forfar.

20. *Prize to Mr. Ruhmkorff.*—The prize of 50,000 francs, offered by the Emperor Napoleon for the most useful application of electricity, has been awarded to Mr. Ruhmkorff for his induction coil. The king of Hanover, having heard of the award, forwarded to Mr. Ruhmkorff a large gold medal "pour le mérite."—*Reader*, July 9.

21. *Prize to Mr. Sorel.*—The prize founded by the Marquis d'Argenteuil for the most useful discovery for the perfecting of French industry, has been awarded to Mr. Sorel, the inventor of the process of the "zincage of iron," known under the name of *galvanizing iron.*—*Les Mondes*, May 26.

22. *Alger's Cabinet of Minerals for sale.*—The mineral cabinet of the late Francis Alger is one of the best in the country, and will be a valuable acquision to any institution desiring a first rate collection. It can be examined at the former residence of Mr. Alger, Fourth street, Boston. For terms, which it is stated will be low, reference should be made to S. E. Sewall, or Francis Alger, administrators of Mr. Alger's estate.

OBITUARY.

Evan Pugh, Ph.D., F.C.S., President of the Agricultural College of Pennsylvania, died at Bellefont, Pa., April 29, 1864, aged 36.

Dr. Pugh was one of the most able scientific men of this country. A blacksmith's apprentice at the age of nineteen, he bought the residue of his time, supported himself for one year at the manual labor Seminary at Whitestown, N. Y., and after teaching a private school for boys in Oxford, Pa., his native place, for about two years, he went to Europe where he spent four years in the universities of Leipsic, Göttingen and Heidelberg, and in Paris, a most diligent and successful student of natural and mathematical science. At Göttingen he honorably sustained the examinations for the degree of Doctor of Philosophy.

From the outset, his mind had been attracted toward agricultural science and his studies shaped themselves more and more toward his future career, though he found time to study, as he had the capacity to master, the highest mathematics. Before leaving Paris he addressed to Mr. J. B. Lawes the distinguished English agriculturist, so well known by the numerous and valuable researches carried on at his estate of Rothamstead near London, a proposition to undertake a new investigation of the question, then so vigorously mooted in France between Boussingault and Ville, as to the assimilability of free nitrogen by vegetation. Mr. Lawes received this proposition favorably and signified his willingness to have the research carried on in his laboratory and to defray all the costs, provided Dr. Pugh could satisfy him of his ability to estimate nitrogen with a certain degree of precision. Dr. Pugh repaired to Rothamstead,

and by a skillful application of volumetric methods shortly satisfied Mr. Lawes. For two years, our lamented countryman devoted himself to the solution of the problem which was in dispute, repeating his trials and modifying his devices until he demonstrated, beyond any reasonable doubt, that Ville, and the Commission of the French Academy which reported favorably on his researches, were wrong, and Boussingault right.

Although Mr. Lawes was anxious to retain Dr. Pugh in his laboratory at a handsome remuneration, and notwithstanding the latter was passionately fond of cultivating the fields of scientific research, he returned home in the autumn of 1859, after an absence of six years, to assume the presidency of the Agricultural College of Pennsylvania which had been offered him. He entered at once upon his new duties with characteristic energy and intelligence. He had visited and carefully studied the chief agricultural academies and schools of Europe, and his idea of what an American agricultural college should be was as definite as it was comprehensive and just.

For a little more than five years, Dr. Pugh labored untiringly in establishing his college on a broad and enduring basis, securing funds, planning and superintending the erection of buildings, and besides taking the general guidance of the institution, himself giving instruction in scientific agriculture, chemistry, mineralogy and geology. In the midst of his heavy duties and still heavier cares, he continued vigorous and with every promise of long usefulness until one week previous to his unexpected death.

Dr. Pugh's career as a scientific investigator began when he was a student with unusual promise; but was suspended on his assuming the presidency of an unformed and struggling institution, unfortunately never to be resumed.

While in Europe Dr. Pugh made the investigations that form the subjects of his published contributions to science. They are principally the following, viz:

Hämatinsalpetersäure identisch mit Pikraminsäure, Journal für Prakt. Chemie, lxv, 362.

Miscellaneous Chemical Analyses, Inaugural Dissertation, Göttingen, 1856.

On a new method of estimating Nitric Acid, Quart. Jour. Chem. Soc., xii, 35; and

On the Sources of the Nitrogen of Vegetation with special reference to the question, whether plants assimilate free or uncombined Nitrogen, Phil. Trans., ii, 1861, 150 pp., 4to.

The last mentioned investigation was made in connection with Messrs. Lawes and Gilbert; but Dr. Pugh's share in the work was by no means the least. He devoted to it two years of nearly constant labor and its results are in a high degree satisfactory. He did not merely confirm Boussingault's conclusions and refute the gross errors of Ville, but by a careful investigation of collateral questions demonstrated a rare degree of talent in handling a scientific question.

The Agricultural College of Pa., the first institution of the kind established in this country, was attaining a high degree of success and usefulness, as a result of the rare combination of scientific and practical knowledge with administrative energy which characterized its lamented President. His death is a loss to Pennsylvania and to the nation which cannot be soon made good.

Francis Alger, author of "Alger's Phillips's Mineralogy," died on the 27th of November last, in the 56th year of his age.

VI. MISCELLANEOUS BIBLIOGRAPHY.

1. *Review of American Birds in the Museum of the Smithsonian Institution;* by S. F. BAIRD. Part I, North and Middle America. Sheets 1, 2 and 3, 48 pp., 8vo; to be continued. Smithsonian Miscellaneous Collections, 181. June, 1864.—Dr. Baird, under the auspices of the Smithsonian Institution, has here commenced the publication of a work on the Birds of America. Although intended as a catalogue, with critical notes, of the species in the Smithsonian Collections, it will include references to all species examined anywhere by the author, besides a mention, at the end of genera or families, of species not seen by him. Under the term "North America" is comprised all of America north of a line from the Rio Grande on the Gulf of Mexico to Guaymas on the east side of the Gulf of California; and under that of "Middle America" the part south of this line to the continent of South America together with the West Indies. The references, in the first three sheets issued, are very complete, and the critical notes full and discriminating, such as might be expected from the accuracy and science of the author.

As the specimens of the Smithsonian Institution have been collected largely by the various government exploring expeditions or by special private expeditions, and under the direction in part of the Smithsonian Institution, the author has the material for a thorough discussion of the geographical distribution of species, and the presentation of the facts under this head will, as the author states, be one great object before him.

2. *Observations on the Terrestrial Pulmonifera of Maine, including a Catalogue of all the species of Terrestrial and Fluviatile Mollusca known to inhabit the State;* by EDWARD S. MORSE. 64 pp., 8vo, with numerous cuts. From the Journal of the Portland Society of Natural History, March, 1864. Portland, Maine.—This annotated catalogue of the species of Maine Terrestrial Pulmonifera is quite fully illustrated by woodcuts. These cuts represent the shells of a number of the species, and also, for many of them, the buccal plate, and the lingual membrane with its denticles, besides, in a few cases, other details, such as magnified views of the exterior surfaces of the shells, etc.

3. *The American Annual Encyclopedia and Register of Important Events of the year* 1863—*embracing Political, Civil, Military and Social affairs; Public Documents; Biography, Statistics, Commerce, Finance, Literature, Science, Agriculture, and Mechanical Industry.* Volume III. 866 pp., large 8vo. D. Appleton & Co., New York. 1864. —The general character of this bulky annual, published as a continuation of Appleton's Encyclopedia, has been stated in former notices, and the scope of the work is mentioned in the above title. The political events of the year are detailed at much length and with a number of woodcut illustrations. In Science, there are articles in the departments of Chemistry, Astronomy, Physics, Ethnology and Anthropology, Geographical Explorations, on Iron and Steel, etc., etc., under which much valuable information is presented.

4. *Passages from the Life of a Philosopher;* by CHARLES BABBAGE, Esq., M.A., F.R.S., etc., etc.—The philosopher referred to in the title of this volume is "Charles Babbage, Esq., M.A., F.R.S.," etc., etc., the inventor of the Calculating Machine.

LIBRARY OF THE UNIVERSITY

Abstracts of Meteorological Observations made at the Magnetical Observatory, Toronto, Canada West, during the years 1854 to 1859, inclusive. 136 pp. 4to. Toronto, 1864.

An elementary Text-book of the Microscope, including a description of the methods of preparing and mounting objects, &c.; by J. W. GRIFFITH, M.D., F.L.S. 12mo. London, 1864.—Van Voorst.

Manual of the Metalloids; by JAMES APJOHN, M.D., F.R.S., &c., Prof. Chem. Univ. Dublin. pp. viii, and 596. London.—Longmans.

On the Archeopteryx of von Meyer, with a description of the Fossil Remains of a Long-tailed species, from the Lithographic stone of Solenhofen; by Professor OWEN, F.R.S., &c. 15 pp., 4to, with 4 lithogr. plates.—From the Transactions of the Royal Society.

Expeditions on the Glaciers; including an ascent of Mont Blanc, Monte Rosa, Col du Géant, and Mont Buét; by a Private of the Thirty-Eighth Artists', and Member of the Alpine Club. London, 1864.

The Central Alps, including the Bernese Oberland, and all Switzerland excepting the neighborhood of Monte Rosa and the Great St. Bernard, with Lombardy and the adjoining portion of the Tyrol; by JOHN BALL, M.R.I.A., Late President of the Alpine Club.—An Alpine guide book.

The Dolomite Mountains. Excursions through Tyrol, Carniola, and Friuli, in 1861, 1862, and 1863; with a geological chapter and pictorial illustrations from original drawings on the spot; by JOSIAH GILBERT and G. C. CHURCHILL. London, 1864.—Longman & Co.

British Conchology; or an account of the Mollusca which now inhabit the British Isles and the surrounding Seas. Vol. II, comprising the Brachiopoda, and the Conchifera from the Family of Anomiidæ to that of Mactridæ; by JOHN GWYN JEFFREYS. London, 1864.—Van Voorst.

The Stream of Life on our Globe: its Archives, Traditions, and Laws, as revealed by modern discoveries in Geology and Paleontology. A Sketch in Untechnical Language of the Beginning and Growth of Life, and the Physiological Laws which govern its Progress and Operations; by J. L. MILTON, M.R.C.S. London.—Hardwicke.

Flora Fossile dell' Etna; by FRANCESCO TORNABENE. 147 pp. 4to, with 10 plates. Sicily.

Ontologie Naturelle, ou Etude philosophique des êtres; by M. FLOURENS. 3d edition. Paris.

Mission Scientifique dans l'Amerique du Sud, par le Dr. B. SCHNEPP. Large 8vo. Paris. 2½ *fr.*

Nouvelle Table Barometrique; par M. R. RADAU. Small pamphlet in 4to. Paris. 1 *fr.*

Sur la Viticulture du sud-est de la France; par Dr. J. GUYOT. 1 vol. large 8vo. 304 pp. Paris. Imperial press.

Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien. For the year 1863. Vol. xiii, 1336 pp. 8vo, with 25 plates.

Acta Academiæ C. L.-C. G. Naturæ Curiosorum. Vol. 30, 4to, with 19 plates. Dresden, 1864.

Hypsometrie von Mähren und österreichisch Schlesien (Heights of Moravia and Austrian Silesia). Die Resultate der Höhenmessungen in Mähren und ö. Schlesien, und eine Höhenschichtenkarte beider Länder enthaltend; verfasst von Carl Koristka, Prof. am k. polytechn. Landesinstitute in Prag etc., und herausgegeben von Wernervereine zur geologischen Durchforschung von Mähren und ö. Schlesien. 150 pp., 4to, with one large chart illustrating the elevation of the surface by a series of colors. Brünn. 1863.

Erläuterungen zu der Karte über die Production, Consumtion und Circulation der mineralischen Brennstoffe in Preussen, während des Jahres 1862. Herausgegeben im Königlich preussischen Ministerium für Handel. Gewerbe und öffentliche Arbeiten. 52 pp. large 8vo, with two charts. Berlin. 1863.

Jenaische Zeitschrift für Medecin und Naturwissenschaft, herausgegeben von der medicinisch-naturwissenschaftlichen Gesellschaft zu Jena. 1st vol. 1st Heft., 124 pp., 8vo, with three copper plates. Leipzig, 1864. W. Engelmann.—The first number of a new periodical. Among the Natural History papers there is a long and valuable memoir on the Corycæidæ—Cyclopoid Crustaceans—by Dr. Ernst Häckel, illustrated by three plates.